



State of California
Department of Water Resources

PROPOSITION 50, CHAPTER 6(a) DESALINATION GRANTS – 2006 FUNDING CYCLE

Summary of Projects Awarded Funding

(9/20/2006)

Project Category	Number of Awarded Projects / Total Applications Received	Awarded Projects Total Cost	Awarded Grant Amount	State Share to Total Cost
Construction Projects	4/12	\$79,615,000	\$9,000,000	11%
Feasibility Studies	4/7	\$1,463,000	\$724,000	49%
Pilot & Demonstrations	9/17	\$22,873,787	\$8,954,577	39%
Research & Development	7/13	\$7,951,510	\$2,860,964	36%
Total	24/49	\$111,903,297	\$21,539,541	19%

CONSTRUCTION PROJECTS

DWR ID	Applicant	Contact Information	Project	Total Cost	Funds Requested	Awarded Grant
C-2006-04	East Bay Municipal Utility District	Hasan Abdullah Desalination Project Coordinator P.O. Box 24055 Oakland, CA 94623 Email: habdulla@ebmud.com	Low Energy Application of Desalination (LEAD) Project	\$14,640,000	\$3,000,000	\$2,900,000
C-2006-07	City of Sand City	Steve Matarazzo Community Development Director 1 Sylvan Park Sand City, CA 93955 Email: steve@sandcity.org	Sand City Water Supply Project (SCWSP)	\$8,375,000	\$3,000,000	\$2,900,000
C-2006-08	City of Oxnard, Water Division	Anthony Immert Interim Water Superintendent 251 South Hayes Street Oxnard, CA 93030 Email: anthony.emmert@ci.oxnard.ca.us	GREAT Program Desalter - Blending Station No. 1	\$20,000,000	\$3,000,000	\$2,900,000
C-2006-10	Irvine Ranch Water District	Steve Malloy, Principal Engineer P.O. Box 57000 Irvine, CA 92619 Email: malloy@irwd.com	Irvine Desalter Project and South Irvine Brine Line	\$36,600,000	\$1,000,000	\$300,000
Total				\$79,615,000	\$10,000,000	\$9,000,000

FEASIBILITY STUDIES

DWR ID	Applicant	Contact Information	Project	Total Cost	Funds Requested	Awarded Grant
F-2006-01	City of Arroyo Grande	Steve Tanaka, Wallace Group Director of Water Resources 4115 Broad Street, Suite B-5 San Luis Obispo, CA 93401 Email: steventanaka@wallacegroup.us	South San Luis Obispo County Desalination Funding Study	\$90,000	\$45,000	\$45,000
F-2006-03	Sweetwater Authority	Rick Alexander, Director of EGS 100 Lakeview Avenue Spring Valley, CA 91977 Email: ralexander@sweetwater.org	Otay River Basin Brackish Groundwater Desalination Study, Phase 1	\$499,000	\$242,000	\$242,000
F-2006-05	San Diego County Water Authority	Robert R. Yamada Seawater Desalination Manager 4677 Overland Avenue San Diego, CA 92123 Email: ryamada@sdcwa.org	Feasibility Study of a Regional Concentrate Conveyance Facility in San Diego County	\$500,000	\$250,000	\$250,000
F-2006-06	City of Oxnard Water Division	Anthony Immert Interim Water Superintendent 251 South Hayes Street Oxnard, CA 93030 Email: anthony.emmert@ci.oxnard.ca.us	Blending Station No. 3 Desalter	\$374,000	\$187,000	\$187,000
Total				\$1,463,000	\$724,000	\$724,000

PILOTS AND DEMONSTRATION PROJECTS

DWR ID	Applicant	Contact Information	Project	Total Cost	Funds Requested	Awarded Grant
P-2006-01	Los Angeles Department of Water and Power	Alvin Z. Bautista Seawater Desalination Program Manager 111 N. Hope Street, Room 1460 Los Angeles, CA 90012 Email: alvin.bautista@ladwp.com	Seawater Desalination Pilot Project	\$2,877,780	\$1,224,300	\$1,224,300
P-2006-04	Affordable Desalination Collaboration	John MacHarg, CEO 1908 Doolittle Drive San Leandro, CA 94577 Email: johnmacharg@hotmail.com	Optimizing Seawater Reverse Osmosis for Affordable Desalination	\$2,368,437	\$1,175,237	\$1,000,000
P-2006-05	East Bay Municipal Utility District	Hasan Abdullah Desalination Project Coordinator P.O. Box 24055 Oakland, CA 94623 Email: habdulla@ebmud.com	Bay Area Regional Desalination Project	\$1,898,600	\$949,300	\$949,300
P-2006-07	U.S. Department of Interior, Bureau of Reclamation	Kevin Price Bureau of Reclamation, D-8230 Denver, CO 80225 Email: kprice@do.usbr.gov	Vertical Tube Evaporator Geothermal Desalination Demonstration Project	\$3,693,500	\$1,500,000	\$1,318,605
P-2006-08	Municipal Water District of Orange County	Richard B. Bell, P.E., Project Manager P.O. Box 20895 Fountain Valley, CA 92728 Email: rbell@mwdoc.com	Test Slant Well - Pilot Plant Treatment and Testing Phase	\$4,171,226	\$1,500,000	\$1,500,000
P-2006-10	City of Avalon	Willard Childs 582 Rancho Santa Fe Rd. Encinitas, CA 92024 Email: willchilds@cox.net	Catalina Large Diameter Membrane SWRO Energy Reduction Project	\$3,637,500	\$1,500,000	\$1,000,000
P-2006-11	Indian Wells Valley Water District	Tom Mulvihill, General Manager P.O. Box 1329 Ridgecrest, CA 93556-1329 Email: tmulvihill@iwwvd.com	Pilot Testing of Zero-Liquid-Discharge Technologies Using Brackish Groundwater for Inland Desert Communities	\$1,189,000	\$578,500	\$578,500
P-2006-12	Board of Water Commissioners of the City of Long Beach	Robert Cheng Deputy General Manager - Operations 1800 E. Wardlow Road Long Beach, CA 90807 Email: robert_c_cheng@lbwater.org	Mitigating Water Quality Effects of Desalinated Seawater	\$2,270,000	\$1,000,000	\$1,000,000
P-2006-14	City of Camarillo	Lucia McGovern Deputy Director of Public Works 601 Carmen Drive P.O. Box 248 Camarillo, CA 93011-0248 Email: lmcgovern@ci.camarillo.ca.us	City of Camarillo Brackish Water Desalination Pilot Study	\$767,744	\$383,872	\$383,872
Total				\$22,873,787	\$9,811,209	\$8,954,577

RESEARCH AND DEVELOPMENT PROJECTS

DWR ID	Applicant	Contact Information	Project	Total Cost	Funds Requested	Awarded Grant
R&D-2006-04	Montara Water and Sanitary District	Tanya Yurovsky, District Engineer 2606 Hyde Street San Francisco, CA 94109 Email: Tanya@SRTconsultants.com	Subsurface Intake Filter Technology Evaluation	\$271,213	\$135,000	\$135,000
R&D-2006-06	Sweetwater Authority	Rick Alexander, Director of EGS 100 Lakeview Avenue Spring Valley, CA 91977 Email: ralexander@sweetwater.org	Zero Discharge Solar Distillation Research and Development Project	\$990,800	\$481,500	\$481,500
R&D-2006-07	West Basin Municipal Water District	Paul Shoenberger 17140 S. Avalon Blvd., Suite 210 Carson, CA 90746 Email: Pauls@wcbwater.org	Critical Raw Water Quality Issues Unique to Seawater: Marine Phytoplankton Blooms, their Associated Biotoxins, and Transient Urban Stormwater Inputs	\$1,245,800	\$496,483	\$496,483
R&D-2006-08	Colorado School of Mines	Tzahi Y. Cath, Ph.D. Research Assistant Professor Colorado School of Mines, Division of Env. Science & Engineering Golden, CO 80401-1887 Email: tcath@mines.edu	Novel Hybrid Membrane Desalination Process with Minimal Pretreatment and Concentrate	\$1,071,702	\$499,957	\$499,957
R&D-2006-09	University of California, Los Angeles	Kim Duiker Contract and Grant Officer UCLA Contract & Grant Admin. 10920 Wilshire Blvd., #1200 Los Angeles, CA 90024-1406 Email: kduiker@resadmin.ucla.edu	Advanced Monitoring, Optimization, and Control Technologies for High-Efficiency Membrane Desalination	\$1,068,256	\$500,000	\$500,000
R&D-2006-10	U.S. Department of Interior, Bureau of Reclamation	Andy Murphy, Chemist Bureau of Reclamation D-8700 P. O. Box 25007 Denver, CO 80225 Email: amurphy@do.usbr.gov	Development of New Chlorine-Resistant Reverse Osmosis membranes	\$2,554,394	\$498,679	\$498,679
R&D-2006-13	Lawrence Livermore National Laboratory	Olgica Bakajin, Group Leader Molecular Biophysics and Functional Nanostructures 7000 East Avenue, L-435 Livermore, CA 94550 Email: bakajin1@llnl.gov	Desalination Using Carbon Nanotube Membranes	\$749,345	\$249,345	\$249,345
Total				\$7,951,510	\$2,860,964	\$2,860,964

Grantee: **East Bay Municipal Utility District**
 Entity Type: **Water District**
 Project Title: **Low Energy Application of Desalination (LEAD) Project**
 Project Type: **Construction - Brackish & Seawater**

Total Project Cost: **\$14,640,000**
 Requested Funds: **\$3,000,000**
 Awarded Grant: **\$2,900,000**

Assembly District: **11**
 Senate District: **7**
 Congressional District: **7**
 County: **Contra Costa** City: **Crockett**
 Latitude: **38 N** Longitude: **122 W**

Project Summary:

The East Bay Municipal Utility District (EBMUD) is seeking grant funding from the Department of Water Resources (DWR) to implement the Low Energy Application of Desalination (LEAD) project in Crockett, California. The objectives of the project are to:

- Improve local and regional water supply reliability by producing 1.5 million gallons per day (MGD) of potable quality water from the Carquinez Strait to partially offset EBMUD's second largest potable water user;
- Create a local water supply west of the Delta that would be of critical value during emergencies such as earthquakes, levee failure or other natural disasters;
- Produce potable quality water from desalination using energy recovered from an alternative energy source (steam) that is currently being lost through pressure reducing stations;
- Collect hands-on information to aid in implementing larger capacity desalination projects at this site or other locations; and
- Conduct outreach to educate the public, permitting agencies, other water agencies, and governmental and legislative representatives on the pros and cons of desalination.

Letters of support /endorsements have been received from the following Bay Area water agencies:

- Marin Municipal Water District (MMWD)
- Santa Clara Valley Water District (SCVWD)
- San Francisco Public Utilities Commission (SFPUC)
- Northern California Salinity Coalition is comprised of the leading ten Bay Area water and wastewater agencies (Alameda County Water District [ACWD], Contra Costa Water District [CCWD], EBMUD, SCVWD, SFPUC, Zone 7 Water Agency, Solano County Water Agency, Sonoma County Water Agency, MMWD, and Delta Diablo Sanitation District)

The LEAD Project will produce potable quality water using steam energy that is currently being lost through pressure reducing stations. Therefore, the project can be operated with no increased demand on the power grid and no increased use of non-renewable energy sources. The LEAD Project will not only augment EBMUD's water supply to further protect against source interruptions during times of drought or emergencies but also further the public's knowledge regarding desalination practices. EBMUD is committed to sharing information with other agencies and with the State of California (State). Beyond advancing the knowledge and applying desalination to our local setting, a successful implementation of the project will greatly bolster public faith and resource agency confidence in desalination as being a practical solution to California's water issues. Table ES-1 provides a summary of how the LEAD Project satisfies the criteria set by DWR for selecting successful projects for funding.

Project Description: The food processing plant uses 23 MGD of Carquinez Strait water for spray

condensers. This project will use a portion of that cooling water (up to 3.0 MGD), following its use in the plant's existing spray condensers, and direct that 3.0 MGD as the feedwater to the desalting plant. The 3.0 MGD cooling water supplied to the desalination plant will produce 1.5 MGD of potable quality water for use by the food processor, thus off-setting 1.5 MGD of potable water usage for EBMUD customers. A next phase larger capacity project is being considered at this site for supplying potable water to other EBMUD customers.

The desalination reject water (concentrate) would be blended with the return flow of cooling water and discharged back into the Carquinez Strait through an existing plant outfall (labeled as discharge number E001 on Figure below). The desalted water, following its use in the plant for industrial processes, will be discharged back into the Carquinez Strait via the food producer's existing on-site wastewater treatment plant. The power required for operating the desalination facilities will be acquired from an alternative energy source (i.e., steam). Newly installed power generating equipment will recover sufficient steam energy to entirely power the desalination facility with no increase demands on fossil fuels.

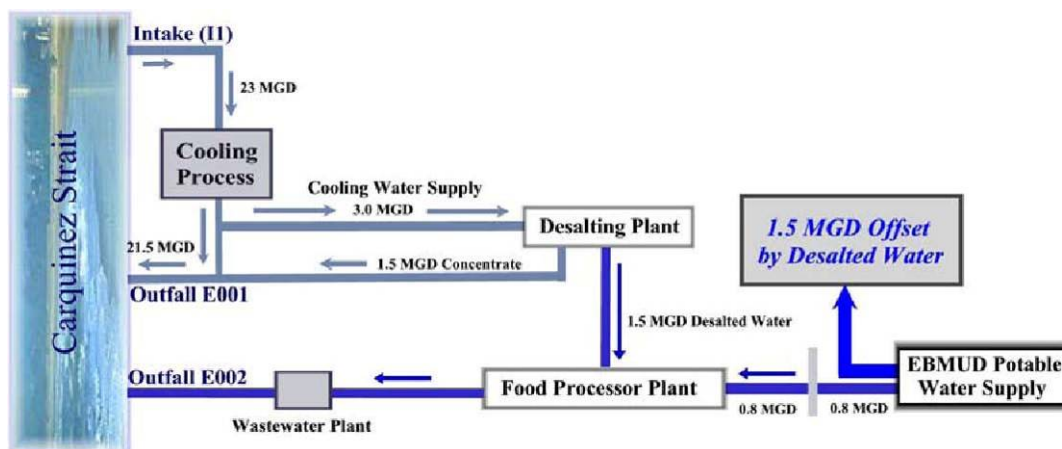


FIGURE: Project Summary

Produce Potable Water from Recovered Steam Energy: An alternative energy source (steam) will be used to operate the desalination facilities. The steam energy would be recovered by replacing the existing steam pressure reducing equipment with a state-of-art power generating unit.

Innovations/Scientific Merit: Innovative technological and management solutions will be used to address the challenges of this project such as:

- Produce potable quality water from a feedwater source with wide range of variations in qualities (salinity range of 1,000 to 26,000 mg/L, turbidity, silt content, temperature effects);
- Use state-of-the-art energy recovery systems to lower the energy consumption; and
- Operate facilities to coincide with current production cycle (i.e., 12 days on, 2 off).

Project Costs: The total project cost is estimated to be \$14.6 million, 80% of which will be paid by EBMUD, only a 20% matching contribution is requested from DWR. The projected water production cost is \$990/AF (intermittent operation to coincide with the food producer's operating schedule).

Schedule: Desalted water production is scheduled to start by 2009, within the timeframe of the current grant funding cycle.

Outreach Plan: An extensive education, outreach, and information-sharing program to educate the public, media, water agencies, permitting agencies, government agencies, legislature, and other interested private/public entities is proposed.

Grantee: **City of Sand City**
 Entity Type: **City**
 Project Title: **Sand City Water Supply Project (SCWSP)**
 Project Type: **Construction - Brackish Water**

Total Project Cost: **\$8,375,000**
 Requested Funds: **\$3,000,000**
 Awarded Grant: **\$2,900,000**

Assembly District: **27**
 Senate District: **15**
 Congressional District: **17**

County: **Monterey** City: **Sand City**
 Latitude: **36 37 N** Longitude: **121 51 W**

Project Summary:

The City of Sand City (Sand City) is located along the California Coast between Monterey and Marina. The proposed Sand City Water Supply Project (SCWSP) is the construction and operation of a reverse osmosis (RO) desalination facility to serve a residential population of 1,029 and three million square feet of commercial and industrial development in Sand City. The SCWSP will provide up to 300 acre feet per year (AFY) of potable water added to the current California-American Water Company (Cal-Am) supplies.

OBJECTIVES

The City's objectives for the construction and operation of a proposed 300 AFY RO desalination facility system are:

- Implement a new water supply project, coordinated with other Cal-Am water sources, without creating significant water quality or biological resources impacts;
- Build desalination water treatment facilities with a cost efficient, economic and environmentally sensitive design in order to supply safe drinking water at a reasonable cost for water customers in Sand City;
- Use the brackish water supply along the City's coastal area, which is independent of the (deeper) Seaside groundwater aquifer, as a water source for RO treatment to potable water;
- Sell potable water to Cal-Am for distribution through its existing system, increasing the regional water supply for the purposes of implementing Sand City's General Plan and Redevelopment Plan, Coastal Plan and long-range land use goals and objectives, including the elimination of urban blight; and
- Reduce use of the Carmel River Basin and Seaside Groundwater Basin water, which are currently in overdraft conditions.

The SCWSP has the following qualities which make it environmentally benign and capable of being completed within one year of any Proposition 50 grant award. These qualities are:

1. The project was EIR-certified in January 2005, and there has been no public opposition to the project.
2. The California Coastal Commission unanimously approved the project, by acclamation in May, 2005, approving its coastal development permit. The Commission found the project to be consistent with all of its 2004 design and locational criteria.
3. The 300 AFY desalination facility will use an untapped brackish water supply along the Sand City coast line whereby, upon a 40 percent recovery rate for the potable water supply, the byproduct water will be at an equivalent salinity to that of Monterey Bay, i.e., there will be no standard brine discharge.
4. The project has the written support of the Desalination Institute of CSU Monterey Bay and the written support of all local state legislators.

5. The water supply project will result in less pumping from two over-drafted aquifers on the Monterey Peninsula. As a result, the City has a letter of intent from the major water purveyor on the Monterey Peninsula, Cal-Am, to work with the City to supply additional water in exchange for the right to reduce pumping in those aquifers for an interim time frame. As required by the Coastal Commission, the desalination plant would remain publicly owned by the City of Sand City.
6. The partnership of Cal-Am and the City has the written support of the State Water Resources Control Board (SWRCB).
7. The water supply project will allow the City of Sand City to continue with its redevelopment program, thereby eliminating urban blight on the Monterey Peninsula. In 1987, the entire City was designated a redevelopment project area, consistent with the California Community Redevelopment Law, due to its industrially-blighted condition.

SCOPE

The components of the project are summarized below.

Feed Water Intake and Concentrate Discharge Wells: The feed water source for the RO desalination facility will be brackish water pumped from wells in the shallow aquifer adjacent to Monterey Bay in Sand City. The reject concentrate will be disposed of by percolation into another portion of the same aquifer using a shallow horizontal well that will be located intermediately between the two intake wells.

Reverse Osmosis (RO) Desalination Facility: The RO desalination facility will be sized to produce 300 AFY (270,000 gallons per day) of potable water. It will produce potable water with a TDS of about 175 mg/l from an intake of brackish water with an approximate TDS content that ranges from 15,500 mg/l to 25,500 mg/l. The reject concentrate will be diluted with additional feed water as necessary to maintain a final discharge that is no more saline than seawater (35,000 mg/l or lower).

Potable Water System Pump Station and Connection to the Cal-Am System: The RO desalination facility will deliver water to the Cal-Am system at the intersection of Catalina Street and Olympia Avenue where Cal-Am has a 14-inch transmission main. Water pressure at the point of connection to the Cal-Am system is about 125 psi. This will require a pump to handle the flow for the treatment facility to transmit the potable water from the chlorine contact and blending tank to the 14-inch transmission main.

Backup Power Supply: Since the treatment facility and pumping system is planned for continuous operation, a standby electrical power-generating facility will be necessary to ensure uninterrupted service in the event of failure of the primary power supply. The backup power facility will be sized to accommodate the peak power demand of the entire desalination system (RO Facility, intake wells, and concentrate disposal) and potable water pipeline to the Cal-Am system.

Emergency Connections and Backup Supply: With the pending agreement between Sand City and Cal-Am the requirement for an emergency water supply is eliminated. The Sand City water system will continue to operate in its existing configuration. If there are times when the desalination facility is not operating, water will continue to be supplied by the Cal-Am system. If the Cal-Am system is in need of additional water it can be supplied from the Sand City desalination treatment facility.

Grantee: **City of Oxnard, Water Division**
 Entity Type: **City**
 Project Title: **GREAT Program Desalter - Blending Station No. 1**
 Project Type: **Construction - Brackish Water**

Total Project Cost: **\$20,000,000**
 Requested Funds: **\$3,000,000**
 Awarded Grant: **\$2,900,000**

Assembly District: **35, 41**
 Senate District: **23**
 Congressional District: **23**

County: **Ventura** City: **Oxnard**
 Latitude: **34 12 N** Longitude: **119 10 W**

Project Summary:

Western Ventura County ("the Oxnard Plain") supports a broad variety of land uses. Located approximately 60 miles northwest of downtown Los Angeles and 35 miles south of Santa Barbara, the Oxnard Plain is unique in its success in merging productive agricultural land uses with a growing ocean-side municipal and industrial population center. The City of Oxnard, with approximately 192,000 residents, is the largest city in the Oxnard Plain and Ventura County and the twentieth largest in the state.

Oxnard owns and operates its own municipal water supply system. Oxnard utilizes both local and imported water supplies. Its water supply sources are a blend of local groundwater produced through Oxnard's own groundwater wells, local groundwater Oxnard purchases from the United Water Conservation District (UWCD), and imported surface water purchased from the Calleguas Municipal Water District (CMWD), a member agency of the Metropolitan Water District of Southern California (MWDSC).

As part of its master planning process, Oxnard determined that it must develop additional alternative water supply sources to continue meeting its goal of providing current and future city residents and businesses with a reliable and affordable source of good quality water. Supply limitations of both Oxnard's local groundwater and imported water sources, as well as the anticipated increasing cost of imported water, justify Oxnard's exploration of alternative water supply source development.

Discussion among Water Division staff and representatives from the other affected agencies has led to the development of the Groundwater Recovery Enhancement and Treatment (GREAT) Program.

The GREAT Program develops local water resources for the benefit of the following:

- Oxnard potable water customers
- Recycled water customers in the southern portion of Oxnard
- Agricultural irrigation in the Ocean View Municipal Water District (OVMWD)
- Agricultural irrigation in the Pleasant Valley County Water District (PVCWD)

The GREAT Program accomplishes this by implementing a water recycling program, a groundwater injection program, and a groundwater desalination program to more efficiently utilize existing local water resources.

Similar to many agencies throughout California, Oxnard is dependent on imported water sources, despite the availability of local groundwater. Unfortunately, this local groundwater is not readily usable due to water quality concerns, primarily total dissolved solids (TDS) and other salts. TDS levels are at or exceed 1,100 mg/l in the groundwater. In order to utilize this local water supply, Oxnard would need to treat the groundwater with a membrane treatment process, such as reverse osmosis (RO). Cost effective and innovative approaches for membrane treatment enhance the opportunities to treat brackish groundwater. Brackish groundwater represents a substantial, but yet largely untapped, resource for potable water supply.

Project Objectives

The objectives of the GREAT Program Desalter are to:

- Enable the development of new local potable water supplies through the construction of brackish groundwater desalination facilities.
- Reduce the need to receive additional imported water that would require improvements to the imported water conveyance system.
- Provide a cost-effective and reliable water source that improves the overall water quality delivered to customers.

Project Scope

The concept of the GREAT Program Desalter is based on the understanding that the City of Oxnard will require additional supplies of water, given the current groundwater and surface water availability projections. In lieu of purchasing imported water for blending, the GREAT Program will provide treated local groundwater for blending. The GREAT Program Desalter will treat groundwater, by RO, pumped from three (3) new wells located on the property immediately south of Blending Station No. 1, which will draw groundwater from the upper aquifer systems (Mugu and Oxnard aquifers). Treated water from the wells will be blended with unchlorinated water from the existing wells and finished water from CMWD. This blending will occur under pressure, in the City's Blending Station No. 1 Facility.

The GREAT Program Desalter meets the eligibility requirements for the Brackish Water and Seawater Desalination Construction Program, as follows:

- Advances the technology for brackish groundwater desalination by providing a cost-effective means of RO treatment by utilizing the existing well field pumps to feed the RO membranes, thus eliminating the need for a separate RO feed system.
- Increases the ability to tap into local brackish groundwater for the development of local potable water supply.
- Incorporates measures for energy efficiency by certifying the buildings as "Green" through the LEED Certification Program.
- Further energy efficiency and advancement in technology will be achieved through the incorporation of energy recovery device.

Grantee: **Irvine Ranch Water District**
 Entity Type: **Water District**
 Project Title: **Irvine Desalter Project and South Irvine Brine Line**
 Project Type: **Construction - Brackish Water**

Total Project Cost: **\$36,600,000**
 Requested Funds: **\$1,000,000**
 Awarded Grant: **\$300,000**

Assembly District: **70**
 Senate District: **33**
 Congressional District: **48**

County: **Orange** City: **Irvine**
 Latitude: **33 40 04 N** Longitude: **117 45 55 W**

Project Summary:

The Irvine Desalter Project (IDP) is a joint groundwater quality restoration and utilization project by the Orange County Water District (OCWD) and the Irvine Ranch Water District (IRWD), with financial participation by the U.S. Department of the Navy (DON), to beneficially use the groundwater for potable and nonpotable purposes in the vicinity of the former Marine Corps Air Station (MCAS) at El Toro Base.

The IDP includes the construction of one potable water reverse osmosis (RO) treatment system and two nonpotable water/air treatment systems. The nonpotable treatment systems will be constructed as part of the IDP; however, the DON is responsible for the costs of these facilities, which are being installed to remediate VOC contaminated groundwater near the MCAS at the El Toro Base. The nonpotable water will meet Title 22 recycled water requirements for reuse. Groundwater from the Irvine Sub-basin in areas outside the DON VOC plume will be extracted and treated to the drinking water standards set forth by the US EPA and California DHS. Natural geologic conditions and past agricultural drainage have resulted in undesirable levels of total dissolved solids (TDS) (> 1,000 milligrams per liter (mg/L)), nitrates, and selenium in the potable groundwater supply wells. VOCs have not been detected in the potable groundwater well locations. The potable treatment system will generate drinking water for Zone 3 of the IRWD service area. In addition to development of a new drinking water supply, by pumping and treating the groundwater containing elevated salts, selenium, and nitrates, the IDP will essentially prevent the migration of these contaminants from the Irvine Sub-basin into the main Orange County Groundwater Basin, which is located just west of Irvine.

The IDP treatment facilities will generate waste brines, which call for a regional salinity management plan to facilitate development of the local water supply, while protecting and improving the groundwater basin and watershed. The South Irvine Brine Line (SIBL) project is a brine conveyance and disposal line currently under construction that will collect non-sewage brine discharges and convey them to a new South Orange County Wastewater Authority (SOCWA) Effluent Pump Station that will pump the treatment system brine directly to the existing Aliso Creek Ocean Outfall (ACOO) for disposal. Refer to Figure 2 for the location of the SIBL and SOCWA Effluent Pump Station.

Project Goals and Objectives

The major IDP objectives are: (1) To provide a new high-quality, reliable local water supply source, thereby reducing dependency on imported water supplies from Northern California and the Colorado River. The potable treatment system will provide 5,000 acre-feet (1.3 billion gallons) of drinking water, enough for 50,000 people, per year. In addition to potable water supplies, the nonpotable treatment systems will yield an additional 3,900 acre-feet of water, enough for 1,300 acres of landscape irrigation annually. (2) To protect downgradient wells from migration of impaired, poor quality groundwater.

The major objective of the SIBL is to provide brine disposal from the IDP to export minerals from the basin, rather than contributing to increasing recycled water salinity caused by discharging waste brines to the sewer where they commingle with municipal wastewater. Mixing these two waste streams increases the TDS of the wastewater, elevates recycled water salinity levels, and further contaminates the

watershed, forcing the District to use potable water supplies. Increased potable demands are partly the result of elevated recycled water salinity caused by the lack of a regional brine disposal system. The SIBL will provide positive brine disposal.

Project Description

The IDP will consist of three separate systems of wells, pipelines, and treatment plants: Potable Treatment Plant (PTP), Principal Aquifer Treatment Plant (nonpotable, PATP), and the Shallow Groundwater Unit (SGU) treatment facility (nonpotable). Each system will operate independently, with separate wells, pipelines, and treatment facilities. Proposition 50 funding will be used for the potable component of the IDP. The IDP Potable Water System will consist of a series of wells located near Interstate-5, conveyance pipelines, and treatment facilities. Groundwater from the Irvine Sub-basin in areas outside the principal aquifer VOC plume will be extracted and treated to remove TDS, nitrates, and selenium. Groundwater from five wells will be conveyed to the PTP for treatment during the initial phase of the IDP. Three new wells (Well Nos. 76, 77, and 110) will be drilled to a depth to intercept the high salinity/nitrates plume generated in the foothill forebay. The fourth and fifth wells (Well Nos. 107 and 115) are existing wells that will be rehabilitated as part of the IDP. Two more wells may be added to the project in future phase(s). The raw water transmission system will consist of new pipelines and existing pipelines that will be sliplined to convey groundwater to the PTP. Pipeline sizes will range from 12 to 24 inches in diameter.

The PTP will treat groundwater using chemical pretreatment, RO membranes, decarbonation, chemical conditioning, and disinfection using sodium hypochlorite and aqueous ammonia. The PTP will feature two RO trains and have an initial product water capacity of approximately 3,500 gallons per minute (gpm) with a buildout capacity for up to 5,700 gpm in the future. The finished potable water will be discharged to Zone 3 of IRWD's potable water distribution system.

Waste concentrate from the RO treatment process will be discharged to the new SIBL. The SIBL will consist of 4.7 miles of 12-inch diameter pipeline, extending from the IDP in Irvine to the IRWD Los Alisos Water Reclamation Plant (LAWRP). At LAWRP, brine will be pumped via the existing SOCWA Effluent Transmission Main (land outfall) to the existing SOCWA ACOO. IRWD is a member agency of SOCWA and owns capacity in the ACOO. The SIBL will export approximately 600 afy of brine containing 5,400 tons per year of salts from the groundwater basin.

Grantee: **City of Arroyo Grande**
 Entity Type: **City**
 Project Title: **South San Luis Obispo County Desalination Funding Study**
 Project Type: **Feasibility Study - Seawater**

Total Project Cost: **\$90,000**
 Requested Funds: **\$45,000**
 Awarded Grant: **\$45,000**

Assembly District: **33**
 Senate District: **15**
 Congressional District: **22**
 County: **San Luis Obispo** City: **Arroyo Grande**
 Latitude: **35 06 02 N** Longitude: **120 37 27 W**

Project Summary:

Three public water agencies, each located in the Southern portion of San Luis Obispo County (SSLOC), have identified the need for a supplemental water source to enhance the reliability of their existing water supply. The City of Arroyo Grande, City of Grover Beach, and the Oceano Community Services District, henceforth the Stakeholders, have performed several preliminary water supply studies. Findings from these studies have shown that a new water source will be required to meet the Stakeholders projected water demands. Results of these preliminary feasibility studies have also shown that the most cost-effective and viable alternative for additional potable water in the South San Luis Obispo County area appears to be seawater desalination. In order to further evaluate the viability, and advance towards design, of a desalination facility to serve the SSLOC water agencies, the Stakeholders have committed to performing a Seawater Desalination Funding Study. The main objectives of the SSLOC Funding Study include preliminary design of the desalination facility, which would then be used to renovate the proposed cost estimate of the project. In addition, the Funding Study would refine previous efforts to outline regulatory and environmental issues associated with seawater desalination, while outlining other possible funding sources, such as construction grant funding or low interest loan programs.

The implementation of a seawater desalination facility for the SSLOC agencies will be designed to supplement the existing water supply and conservation methods currently being utilized by the Stakeholders. While water recycling and conservation efforts are continually being evaluated and performed by the Stakeholders, projected water demand at build out will far exceed the quantity of water saved through conservation. The seawater desalination project will be designed to meet the Stakeholder's deficiency without producing an excessive amount of water that might be construed as growth-inducing. In addition, providing a seawater desalination facility on the Central Coast will result in some of the highest quality water in the State due to the state-of-the-art treatment technologies utilized in seawater desalination facilities. The proposed SSLOC Funding Study will involve the following task objectives:

Preliminary Design - Develop overall design criteria for all components of the desalination plant, intake facility, brine disposal, and product water delivery systems. This section will include a hydrogeologic assessment of the area where the proposed intake facility will be located. The hydrogeologic assessment will also be used to determine the chemical make-up of the source water to assist with the design of the membranes in the reverse osmosis filter system. Additional tasks under the preliminary design include:

- *Design of the seawater intake facility and pipeline.* This design should include an evaluation of several viable intake structures (brackish water wells, beach wells, or open intakes) to determine the best-fit alternative.
- *Design of reverse osmosis filter system.* This design should include further analysis of the various desalination reverse osmosis filter technologies available.

- *Detailed review of ocean outfall.* The funding study should provide a detailed analysis of the capacity constraints, impacts to permitted dilution ratios, and an assessment of the need for a brine equalization tank prior to discharge.
- *Design of the product water distribution system.* The funding study should look into the details of each agency's water distribution system to determine the best location for tie-in to receive desalination product water.
- *SSLOCSD WWTP site analysis.* The funding study should also include correspondence with the SLO County Planning Department to outline the specific requirements for the planning, design, and construction issues in order to obtain a construction/building permit for the desalination plant at the SSLOCSD WWTP location. The site analysis should also address specific design and construction considerations needed for building within a flood plain.

Regulations and Permitting

- The Funding Study will further define and identify specific requirements for obtaining regulatory permits. The Funding Study will provide the necessary information to better understand the regulatory permit process. Understanding the permit process will be a key aspect of viability and implementation of this project.
- The Funding Study will prepare the agencies for most of the issues that will be evaluated as part of the environmental impact review (EIR) process.

Cost & Funding Update

- Refine capital, O&M and life cycle cost of recommended project. Based on this information, respective agencies may prepare rate studies to determine potential rate impacts to customers.
- Prepare and update implementation schedule, including permitting issues.
- Identify potential sources for additional funding.

It is anticipated that the SSLOC Funding Study will be completed in approximately six months and the total cost of the project is expected to be \$100,000, including administrative costs. While it is expected that the SSLOC Funding Study will be available in a public competitive bidding process, a qualified team of engineering consultants has been selected to perform the SSLOC Funding Study. The selected team includes Wallace Group, a local qualified engineering firm to perform the majority of the preliminary design and cost update, with assistance from Cleath & Associates, a hydrogeologic specialist, and Boyle Engineering, to assist with the specific design of seawater desalination technology.

Some of the most important benefits of preparing the SSLOC Desalination Funding Study are to determine the viability of constructing a seawater desalination facility on the California Central Coast while maintaining the Stakeholder's commitment to economical and environmentally sensitive design. While previous studies have been prepared and recommend seawater desalination as the most viable alternative for supplemental water supply to the South San Luis Obispo County water agencies, a more in-depth analysis is crucial in determining the preliminary design and cost of the proposed facility. The SSLOC Funding Study will be used as a stepping stone to complete design of a SSLOC desalination facility.

Grantee: **Sweetwater Authority**
 Entity Type: **Water District**
 Project Title: **Otay River Basin Brackish Groundwater Desalination Study, Phase 1**
 Project Type: **Feasibility Study - Brackish Water**

Total Project Cost: **\$499,000**
 Requested Funds: **\$242,000**
 Awarded Grant: **\$242,000**

Assembly District: **79**
 Senate District: **40**
 Congressional District: **51, 53**
 County: **San Diego** City: **Chula Vista**
 Latitude: **32 35 29** Longitude: **117 3 56**

Project Summary:

This application is to support the Feasibility Study phase of the Otay River Basin Brackish Groundwater Desalination Project. The purpose of the Study is to determine the feasibility of extracting brackish groundwater from the San Diego Formation where it underlies the Otay River Basin, treat it at a new desalination facility and deliver the potable water to customers of both the Sweetwater Authority and Otay Water District (the "Districts"), who are partnering on this Project. The first phase of the Study is the subject of this grant application to collect necessary geologic, groundwater and water quality data that can be used to determine the characteristics of the aquifer and to develop a solidified plan for completing a Project that could potentially yield four (4) million gallons per day (mgd) of desalinated potable water.

The achievable goals of this Project are to:

- Obtain valuable well data that can be used to determine the hydrogeological conditions of the San Diego Formation in the Otay River Basin.
- Determine the water quality of the aquifer in this region.
- Conceptually layout the facilities and costs needed to collect, treat and deliver desalinated water to potable water customers of the Districts.
- Develop a Long-Term Monitoring Program for Well Development and an Implementation Plan that clearly identifies the steps needed to complete the ultimate Project.

This Project is relevant and inline with the objectives of the funding program as it would allow, due to the partnering of both agencies, for each agency to complete a significant step towards developing, through the use of desalination technologies, a new potable water source from brackish groundwater that is currently not used.

Many local entities have studied the San Diego Formation and are interested in its potable water potential. These include the San Diego County Water Authority, City of San Diego, Otay Water District, and the United States Geological Service. The San Diego Formation extends from the California-Mexico border to near Mission Bay in San Diego County, a distance of approximately 16 miles from the coast, and approximately 5-6 miles inland. What is known about the San Diego Formation is that the geology is complex and at present, only partly understood. The heterogeneity of the aquifer makes it extremely difficult to accurately predict groundwater flow or well performance. Few, if any, investigations have been performed on the Formation in the Otay River Basin (previous wells had been measured at 2,000 mg/l TDS). Most of the knowledge is based in and adjacent to the Sweetwater River Valley and in the Tijuana River Valley. Therefore, this Project would produce valuable and useful data to aid in characterizing the Formation that could ultimately lead to the production of potable water in the Otay River Basin. It should be noted that the City of San Diego was funded in the prior phase of this Proposition 50 grant program to

perform a feasibility study of the San Diego Formation ("San Diego Formation Brackish G.W. Desalination Project – Phase II"). Their project is located in the community of University Heights in San Diego, which is located within the Mission Valley Basin area of the San Diego Formation. Therefore, the data collected from the City's study is not relevant to the proposed project and provides no useful information for the Otay River Basin.

The Sweetwater Authority has successfully developed a brackish groundwater desalinated water facility (the Reynolds Desalination Plant) in the Sweetwater River Valley that produced 1,986 acre-feet of potable water in 2005 and is expected to produce up to 4,400 acre-feet per year by 2010. Sweetwater and its existing and proposed groundwater desalination projects are compliant with the Groundwater Quality Monitoring Act of 2001 (AB599). Sweetwater participated in the Groundwater Ambient Monitoring Assessment (GAMA) program in 2005. This program was implemented by the California State Water Resources Control Board to satisfy the Groundwater Quality Monitoring Act of 2001. Additionally, the Sweetwater Authority is committed to continue our relationship with the GAMA project in the future.

Otay Water District imports 100% of its potable water from the San Diego County Water Authority, the wholesale supplier for the region. To date, they have been unsuccessful in attempts to develop groundwater resources in their service area. However, as stated in Otay Water District's 2005 Urban Water Management Plan, "One groundwater opportunity of particular interest to the District and other agencies is the San Diego Formation." With Sweetwater Authority taking the lead on this Project, their experience will enable the implementation of an economical and environmentally acceptable Project.

The Districts are both implementing conservation and recycling programs within their service areas to the maximum extent practicable. They are signatories to the "Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California" and actively implement the fourteen best management practices of the California Urban Water Conservation Council. They are committed to water conservation, knowing that water conservation is the best way to protect their water supply resources. Otay Water District also owns and operates the Ralph W. Chapman Water Reclamation Facility that produces 1.1 mgd of recycled water and has signed an agreement with the City of San Diego to purchase an average of at least 6 mgd of recycled water from their South Bay Water Reclamation Plant. Otay continues to expand its recycled water system and has one of the largest distribution systems for recycled water in San Diego County.

The Sweetwater Authority will be the primary contact for the proposed Otay River Basin Groundwater Desalination Study, Phase I. This Study would be completed in 12 months. Benefits to be gained by Phase I alone include increasing the data available on the San Diego Formation and providing this information to the USGS to include in their current study of the Formation. This would allow them to better characterize the whole aquifer and its potential and would be a valuable resource to the entire region. The proposed project would help advance desalination technology by providing an Implementation Plan for the development of new potable water supplies through brackish groundwater desalination that would be applicable for other water purveyors. With the water quality data from the proposed wells and transferring the experience from the Reynolds Desalination Plant, the feedwater treatment processes and strategies will be improved. The proposed desalination facility will utilize new, low pressure reverse osmosis membranes that will reduce power costs over the Reynolds facility. Should the Otay River Basin prove feasible, beach wells for additional feedwater intake will be studied as part of a subsequent phase of the Project.

Grantee: **San Diego County Water Authority**
 Entity Type: **Regional Water Wholesaler**
 Project Title: **Feasibility Study of a Regional Concentrate Conveyance Facility in San Diego County**
 Project Type: **Feasibility Study - Brackish Water**

Total Project Cost: **\$500,000**
 Requested Funds: **\$250,000**
 Awarded Grant: **\$250,000**

Assembly District: **79**
 Senate District: **40**
 Congressional District: **51**

County: **San Diego** City: **Chula Vista**
 Latitude: **32 35 N** Longitude: **117 05 W**

Project Summary:

The San Diego County Water Authority (Water Authority) is requesting Proposition 50 funding for a study on the feasibility of a regional concentrate conveyance facility in southern San Diego County. A regional concentrate conveyance facility could provide an environmentally friendly and economic solution to concentrate management for groundwater desalting facilities. The study will be a collaborative effort among the Water Authority, the Sweetwater Authority, Otay Water District, and the City of San Diego. These Water Authority member agencies currently own and operate, or are in the planning phase of groundwater desalting facilities in southern San Diego County.

The Water Authority is a regional water wholesaler charged by the California Legislature with the responsibility to provide a safe and reliable water supply to the nearly 3 million residents of San Diego County. The Water Authority, along with its member agencies, has worked aggressively to increase local supplies and reduce the region's reliance on imported water supplies. These efforts have included increased groundwater development, conservation, water recycling, and other new local water supplies.

One of the barriers in increasing groundwater development is concentrate management. The majority of groundwater in San Diego County is brackish and requires desalination to treat to potable use. This process creates a concentrate stream that requires discharge. Groundwater desalting facilities without access to an ocean outfall can turn to other options for discharge of the concentrate. For example, deep well injection and drying beds are two common processes; however, these require favorable subsurface conditions and adequate land to be feasible. These are two conditions that are not readily met in southern San Diego County.

A regional concentrate conveyance facility could provide an economic and environmentally friendly solution to the challenge of concentrate management. The regional concentrate conveyance facilities would involve the construction of a pipeline running north to south in southern San Diego County, discharging to the existing South Bay Ocean Outfall (SBOO). Both existing and planned groundwater desalination facilities in the region could utilize the proposed concentrate conveyance facilities. For existing facilities, this would potentially reduce or eliminate impacts and discharges resulting from current concentrate management practices. The project could also facilitate further groundwater development, maximizing the use of existing groundwater supplies.

The feasibility study will evaluate numerous aspects of developing a regional concentrate conveyance facility. These issues include, but are not limited to:

- Geographic regions to be served by the concentrate conveyance facility
- Potential alignments of the pipeline
- Existing and planned desalination facilities that could utilize the discharge pipeline
- Pipeline capacity

- Pumping station size and location, if required
- Environmental impacts and permitting issues
- Concentrate blending characteristics with existing discharges in the SBOO
- Potential marine impacts from combined SBOO discharge
- Cost

The project will be a collaborative effort among the Water Authority and the Sweetwater Authority, Otay Water District, and the City of San Diego. As the regional water provider, the Water Authority will serve as the lead agency for this funding request. Overall project management and project funding will be a collaborative effort among each of the four agencies. The City of San Diego, City of National City, and City of Chula Vista all fall within the jurisdictional boundaries that may benefit from the project.

Grantee: **City of Oxnard, Water Division**
 Entity Type: **City**
 Project Title: **Blending Station No. 3 Desalter**
 Project Type: **Feasibility Study - Brackish Water**

Total Project Cost: **\$374,000**
 Requested Funds: **\$187,000**
 Awarded Grant: **\$187,000**

Assembly District: **35, 41**
 Senate District: **23**
 Congressional District: **23**

County: **Ventura** City: **Oxnard**
 Latitude: **34 13 07 N** Longitude: **119 18 40 W**

Project Summary:

Western Ventura County ("the Oxnard Plain") supports a broad variety of land uses. Located approximately 60 miles northwest of downtown Los Angeles and 35 miles south of Santa Barbara, the Oxnard Plain is unique in its success in merging productive agricultural land uses with a growing ocean-side municipal and industrial population center. The City of Oxnard, with approximately 192,000 residents, is the largest city in the Oxnard Plain and Ventura County and the twentieth largest in the state.

Oxnard owns and operates its own municipal water supply system. Oxnard utilizes both local and imported water supplies. Its water supply sources are a blend of local groundwater produced through Oxnard's own groundwater wells, local groundwater Oxnard purchases from the United Water Conservation District (UWCD), and imported surface water purchased from the Calleguas Municipal Water District (CMWD), a member agency of Metropolitan Water District of Southern California (MWDSC).

As part of its master planning process, Oxnard determined that it must develop additional alternative water supply sources to continue meeting its goal of providing current and future city residents and businesses with a reliable and affordable source of good quality water. Supply limitations of both Oxnard's local groundwater and imported water sources, as well as the anticipated increasing cost of imported water, justify Oxnard's exploration of alternative water supply source development.

Similar to many agencies throughout California, Oxnard is dependent on imported water sources, despite the availability of local groundwater. Unfortunately, this local groundwater is not readily usable due to water quality concerns, primarily nitrate, total dissolved solids (TDS), and other salts. Initial results of wells at Blending Station Number 3 (BS No. 3) indicate nitrate levels at or above the maximum contaminant level (MCL) in two of the four wells. TDS levels are at or exceed 1,100 mg/l in the groundwater. In order to utilize this local water supply, Oxnard would need to treat the groundwater with a membrane treatment process, such as reverse osmosis (RO).

In 2004, Oxnard conducted a Pilot Study to develop proof of concept alternative treatment technologies for the desalting portion of the City's Groundwater Recovery Enhancement and Treatment (GREAT) Program. Three processes were investigated as potential treatment options for the brackish groundwater: standard RO, large diameter RO, and pellet softening. Results from the study showed that water quality from a large diameter RO was very similar to standard RO membranes with a reduced footprint and capital cost.

Cost effective and innovative approaches for membrane treatment enhance the opportunities to treat brackish groundwater. Brackish groundwater represents a substantial, but yet largely untapped, resource for potable water supply. As such, Oxnard is proposing a feasibility and preliminary design study for a large diameter RO desalination facility at its Blending Station No. 3 (BS No. 3 Desalter).

Project Objectives

The objectives of the BS No. 3 Desalter are to:

- Enable the development of new local potable water supplies through the construction of brackish groundwater desalination facilities.
- Improve the desalination process design by implementing large diameter RO membranes and an energy recovery device.
- Reduce the need to receive additional imported water that would require improvements to the imported water conveyance system.
- Provide a cost-effective and reliable water source that improves the overall water quality delivered to customers.

Project Scope

The concept of the BS No. 3 Desalter will be based on the understanding that the City of Oxnard will require additional supplies of water, given the current groundwater and surface water availability projections. The Feasibility Study for the BS No. 3 Desalter will review existing data, develop design criteria for the desalter, and evaluate several alternatives including an elevated versus buried permeate tank and the potential location of the facilities on an adjacent site. The Feasibility Study will also include preliminary design of the desalter facilities for an initial capacity of 5 million gallons per day (MGD) of permeate and an ultimate capacity of 10 MGD.

Treated water from the site will either be blended with water from the existing wells and from UWCD for domestic use, or delivered directly in-lieu of finished water from CMWD to Proctor and Gamble (P&G). P&G currently utilizes 1,500 gallons per minute (gpm) of water from CMWD. Thus the BS No. 3 Desalter could significantly reduce the overall demand for CMWD water, by serving P&G directly.

The BS No. 3 Desalter meets the eligibility requirements for the Brackish Water and Seawater Desalination Feasibility Program, as follows:

- Advances the technology for brackish groundwater desalination by providing a cost-effective means of RO treatment by incorporating large diameter RO membranes.
- Increases the ability to tap into local brackish groundwater for the development of local potable water supply.
- Furthers advancement in technology and energy efficiency through the incorporation of an energy recovery device.

Grantee: **Los Angeles Department of Water and Power**
 Entity Type: **Municipal Utility**
 Project Title: **Seawater Desalination Pilot Project**
 Project Type: **Pilot/Demo - Seawater**

Total Project Cost: **\$2,877,780**
 Requested Funds: **\$1,224,300**
 Awarded Grant: **\$1,224,300**

Assembly District: **53**
 Senate District: **28**
 Congressional District: **36**

County: **Los Angeles** City: **Los Angeles**
 Latitude: **33.91775 N** Longitude: **118.42568**

Project Summary:

The Los Angeles Department of Water and Power (LADWP) is evaluating the feasibility of developing a seawater desalination plant at its Scattergood Generating Station (SGS) in Playa Del Rey. As part of this evaluation, LADWP is studying various means to minimize both costs and potential environmental impacts of the project by locating the facility at an existing power plant and using the plant's water intake system, electrical transmission infrastructure, available land, and disposing desalination concentrate through the Hyperion Wastewater Treatment Plant located adjacent to the project site. The pilot project could be used to showcase the opportunities to develop cost-effective seawater desalination as a potable water supply in coastal areas in an environmentally sensitive manner.

LADWP is committed to developing cost-effective seawater desalination projects in a publicly responsible manner that minimizes environmental impacts. This proposal requests assistance in conducting pilot studies to investigate the technical, economic, and environmental effects of using discharge from the power plant's cooling system as a water supply for seawater desalination. Presently, the power plant cooling-water discharge is more than adequate to supply a full-scale desalination project, and use of this discharge water would not increase or change the inflow of seawater into the power plant. However, because of concerns raised regarding the use of once through cooling from coastal power generating facilities, the pilot project will also perform evaluations to ensure that a full-scale desalination plant could operate using cold water from the ocean, possibly through beach wells or the existing intake structure. This evaluation ensures that a full-scale desalination plant would not create an additional need to operate the power plant's existing cooling system in order to supply water to the desalination plant. Any development of a full-scale plant would require a comprehensive environmental evaluation, which would include an evaluation of the various options for supplying seawater to the desalination plant. LADWP has already received approval for grant funding from the United States Bureau of Reclamation and California Department of Water Resources to complete initial phases of the pilot project.

The available data are insufficient to ensure the viability of using SGS' cooling water discharge as a supply source for a seawater desalination plant without undertaking this pilot study. Additionally, the pilot study will evaluate the most cost-effective methods of pursuing a full-scale plant. Thus, it is the objective of the pilot studies to determine unknown parameters that could affect the cost and reliability of a project serving desalinated water. Any full-scale project must undergo an environmental assessment and the completion of an Environmental Impact Report and Environmental Impact Study to determine its viability.

The overall goal of this project is to test the technology and acquire data that can be subsequently used in designing a full-scale seawater desalination facility. The objective is to improve our understanding of the extent that warmer feed water may complicate the overall desalination process and compare the results to the impacts of using a cold water source. Some of the objectives include:

- Determining the adequacy of micro/ultrafiltration (MF/UF) as a pretreatment of reverse osmosis (RO) to control biological fouling and to evaluate additional methods to prevent biological fouling if this occurs.
- Providing data for the selection of post-treatment processes and/or modifications of the operating parameters of the basic desalination processes to meet objectives for dissolved materials in product water.
- Evaluating how well the desalination process achieves reliable disinfection of the product water.
- Evaluating the effectiveness of the micro/ultrafiltration processes, followed by reverse osmosis treatment, at achieving product water disinfection during potentially adverse seawater quality conditions as may be encountered during the seasonal phases of testing (e.g., red tide, high sea usage periods, and winter storm flow events).
- Determining the power requirements of, and costs for, desalinating ocean water.
- Studying the feasibility, of disposing desalination concentrate through an existing wastewater treatment facility. This analysis will supplement prior studies performed by Scripps Institute of Oceanography regarding potential impacts of concentrate brine disposal into Santa Monica Bay. This information will be used to develop a salt balance to identify the range of operating parameters that produce favorable salinity discharge conditions.
- Working in close consultation with the California Department of Health Services (DHS) to allow DHS certification of elements of the treatment process and/or the adequacy of the treatment process as a whole.

The three phases of testing include:

Pretreatment System Testing - In this phase of testing, the pilot plant will be operated to determine acceptable methods to control fouling of the pretreatment systems and reverse osmosis systems.

Reverse Osmosis Testing - After a preferred method of controlling fouling has been assessed, this phase will use dual R/O systems to test different project configurations. The testing will include the stable operation of one of the R/O systems in the preferred configuration, while the second R/O system will be used to run multiple experiments to determine disinfection characteristics.

Verification Testing - This phase of testing will ensure that the prior results are verifiable. The principal aim of this phase will be to confirm that long-term fouling is as predicted and that the treatment system's performance does not degrade over time. This phase of the testing will run the preferred membranes through several cleaning and recovery cycles.

All the information developed during this pilot project will be shared with interested parties and stakeholders through the Public Awareness Plan which includes regularly scheduled workshops and project reporting.

Grantee: **Affordable Desalination Collaboration**
 Entity Type: **Non-Profit**
 Project Title: **Optimizing Seawater Reverse Osmosis for Affordable Desalination**
 Project Type: **Pilot/Demo - Seawater**

Total Project Cost: **\$2,368,437**
 Requested Funds: **\$1,175,237**
 Awarded Grant: **\$1,000,000**

Assembly District: **41**
 Senate District: **23**
 Congressional District: **23**

County: **Ventura** City: **Port Hueneme**
 Latitude: **34 08 52 N** Longitude: **119 11 39 W**

Project Summary:

A key challenge facing the seawater desalination industry today is to develop a new generation of reverse osmosis (RO) plants that deliver high-quality, fresh water at a reduced economic and environmental cost. The key to achieving these goals is to address the most expensive and environmentally taxing component of operating a desalination system: energy.

The Affordable Desalination Collaboration (ADC) was formed in 2004 to fund and execute the first part (ADC I) of what is hoped to be a multiple phase Affordable Desalination Demonstration Project. ADC I built and is operating a demonstration plant at the United States Navy's Seawater Desalination Test Facility in Pt. Hueneme, California. The plant utilizes a combination of proven technologies developed primarily in the U.S. and California to demonstrate that seawater desalination can be optimized to make it technically and economically viable. To date, ADC I has achieved remarkable results by desalinating seawater at energy levels between 6.0-6.9 kWh/kgal (1960-2250 kWh/acre-ft). On average, these numbers make the power for desalination comparable to the power required for the State Water and the Colorado River Aqueduct projects and they are approximately 35% lower than experts have been projecting for seawater desalination. For the approximate 100 mgd of proposed seawater desalination projects in Southern California alone, this 35% savings will equate to approximately 140,000 Mega Watt hours in energy savings per year.

This proposal seeks funding for this second phase (ADC II) to pursue the following demonstration, and development tasks.

1. Test and demonstrate additional manufacturers' membranes through a similar protocol as phase I, where we have used DOW membranes exclusively. Demonstrating additional manufactures will validate our original results and show that they can be achieved with several manufactures' membranes. It will also allow us to provide a "head to head" comparison matrix of performance from four leading membrane manufacturers (DOW, Hydranautics, Toray, Koch) using natural seawater and a full-scale eight inch diameter x 7-element membrane array.
2. Test and demonstrate DOW's next generation "hybrid-membrane". Their new concept includes internally staging membranes of different performance down a single 7-element pressure vessel. Dow indicates that these new membranes will provide improvements in energy consumption over their latest "low energy" membranes and the hybrid-membrane should also produce better water quality than their existing low energy membrane if used by itself.
3. Develop and demonstrate new process designs that are possible as a result of the isobaric energy recovery technologies. As a natural result of the pressure exchanger (PX) technology in particular, there are new kinds of flow schemes that can improve the performance of higher recovery seawater and brackish water systems. We will use the ADC pilot system to test and demonstrate these new flow schemes in order to push the recoveries above 50%, while still maintaining good water quality and low energy performance.

4. Test and demonstrate Zenon ultra-filtration technology ahead of our ADC pilot system. Although pre-filtration is not necessarily an energy issue, adding this equipment to our system will allow us to run more reliably through a wider range of feed water qualities. As a bonus to that reliability we will also gain additional information about how Zenon's ultra-filtration system performs on Southern California natural seawater. This data should build on and compliment the other pre-filtration studies that are taking place in the region.

The ADC is a group of leading government agencies, municipalities, RO manufacturers, consultants and professionals partnering together to help reduce the costs associated with desalination. A partial list of member-participants that will be invited and will likely participate in the ADC-II project includes:

- Avista Technologies, Inc.
- California Department of Water Resources
- California Energy Commission
- Carollo Engineers
- David Brown Union Pumps-Extron
- FilmTec Corporation
- Energy Recovery Inc.
- Hydranautics Membrane
- Koch Membrane Systems
- Marin Municipal Water District
- Metropolitan Municipal Water District of Southern California
- Municipal Water District of Orange County
- San Diego County Water Authority
- Sandia National Laboratories
- City of Santa Cruz Water Department
- Toray Membrane America
- U.S. Naval Facilities Engineering Service Center Seawater Desalination Test Facility
- US Bureau of Reclamation
- West Basin Water District
- Zenon Environmental Corporation

ADC I did not include any Proposition 50 funds, but was funded by contributions of cash, equipment and in-kind services from 23 founding member organizations.

We represent a unique collaboration that is working together to improve the designs and technology applied in state of the art desalination systems. Through this collaborative approach, we have established a peer review process that is unmatched in our industry. Our demonstration system, site and processes have been pre-qualified and proven in phase I to produce valid data on the energy consumption of seawater desalination systems. Our outreach and information sharing efforts have reached a wide range of audiences including over a dozen presentations at various regional, national and international water conferences, numerous publications, radio talk shows, and a feature on the popular syndicated TV program Beyond Tomorrow. In short, the ADC is an established leader in the field of desalination energy efficiency and we are uniquely qualified to conduct the proposed project and disseminate the results to the appropriate audiences.

Grantee: **East Bay Municipal Utility District**
 Entity Type: **Water Agency**
 Project Title: **Bay Area Regional Desalination Project**
 Project Type: **Pilot/Demo - Brackish Water**

Total Project Cost: **\$1,898,600**
 Requested Funds: **\$949,300**
 Awarded Grant: **\$949,300**

Assembly District: **11, 15**
 Senate District: **7**
 Congressional District: **7, 10**
 County: **Contra Costa** City: **Pittsburg**
 Latitude: **38 02 07.89 N** Longitude: **121 55 41.90 W**

Project Summary:

The East Bay Municipal Utility District (EBMUD) is pleased to submit this grant application for a pilot plant that would advance the development of the Regional Desalination Project (RDP) in the greater San Francisco Bay Area. EBMUD is one of four partner water agencies that are committed to developing a regional project that can either directly or indirectly serve the water needs of more than 5 million residential and business water users in the San Francisco Bay Area.

The partner agencies for the RDP are four of the San Francisco Bay Area's largest water suppliers: EBMUD, the San Francisco Public Utilities Commission (SFPUC), the Santa Clara Valley Water District (SCVWD), and the Contra Costa Water District (CCWD) (hereafter referred to collectively as the partners).

For over three years, the partners have worked together to determine if and how they can collaborate to develop an RDP that would serve each of their needs, while maximizing water supply efficiencies and minimizing environmental and financial costs. Based on their evaluations to date, including the preliminary results of the RDP Feasibility Study (Feasibility Study)¹, the partners are committed to pursuing the RDP.

The partners anticipate pooling their resources to build a single desalination facility, with a maximum capacity of 65 million gallons per day (MGD), in the San Francisco Bay Area. By pooling resources for this effort and leveraging existing conveyance infrastructure, the RDP partners would minimize potential environmental impacts associated with developing independent desalination projects within a small geographic area along the California coastline. Applying a centralized regional approach offers additional benefits such as forming complementary goals and objectives, reducing capital outlays for each partner, and providing effective and coordinated redundancy/backup facilities to be shared by the whole region.

The RDP would serve as a new, safe, and reliable water supply source that can be used to meet the water needs of the partners including providing supplemental water during emergencies and unplanned facility outages, and relief during periods of drought. The RDP would provide a new potable water source consistent with the requirements of Chapter 6(a) of Proposition 50.

Using the preliminary findings from the Feasibility Study, the partners are now prepared to test the operation and maintenance of a joint facility on a pilot scale. The scope included in this pilot plant proposal will enable the partners to (1) establish a joint organization for the operation and maintenance of a regional facility, (2) test technologies and innovative methods for maximizing the efficiency of the plant, (3) identify potential environmental impacts and test ways of mitigating those effects, (4) identify the preferred pretreatment method for the project, and (5) share test data and methodologies with other interested users in the State.

¹ The RDP Feasibility Study is being funded with support from Proposition 50 funds that were allocated in 2005

State funding support for the RDP pilot project will expedite the advancement of an important regional project that will benefit the greater San Francisco Bay Area. It will also enable the project to have a broader reach by serving as a model for other planned desalination projects. Most importantly, Chapter 6(a) funding will demonstrate the State's commitment to a project that strives to use innovative solutions and an integrated regional approach to addressing critical water challenges in California.

Grantee: **Bureau of Reclamation, U.S. Department of Interior**
 Entity Type: **Federal Agency**
 Project Title: **Vertical Tube Evaporator Geothermal Desalination Demonstration Project**
 Project Type: **Pilot/Demo - Brackish & Seawater**

Total Project Cost: **\$3,693,500**
 Requested Funds: **\$1,500,000**
 Awarded Grant: **\$1,318,605**

Assembly District: **80**
 Senate District: **40**
 Congressional District: **51, 45, 10**
 County: **Imperial** City: **Calipatria**
 Latitude: **33 09 26.32 N** Longitude: **115 38 51.60 W**

Project Summary:

The Vertical Tube Evaporation (VTE) Geothermal Desalination Demonstration Project (Project) here proposed will demonstrate that steam-driven thermal desalination using a multi-effect, vertical tube evaporator is a viable technology for the production of potable water in situations where water is needed, heat to produce steam is available, and there is a nearby source of impaired water available for treatment. The Project location, California's Imperial and Coachella Valley regions, includes all of these characteristics; i.e. the need for water, available geothermal heat, and impaired water sources. The Project will seek to demonstrate novel improvements on an existing thermal desalination technology (Multi-Effect Vertical Tube Evaporation) in a new application, using geothermal steam as an energy source. In past work this technology has been shown to be efficient, scalable, and easily maintained. The technology will address specific challenges and opportunities of the region with respect to a uniquely challenging water chemistry and the availability of heat not currently in commercial use. Moreover, the Project will also produce results that are transferable to other areas where industrial heat sources and impaired water can combine to create an opportunity for VTE co-generated water supplies in an economically feasible fashion. An economic planning tool will also be created as part of this project that will assist decision makers to determine when it makes economic sense to install a water cogeneration VTE facility next to a source of heat.

The Project will focus primarily on producing potable water from highly saline Salton Sea water (at or near 45,000 mg/L total dissolved solids) with additional tests on locally available brackish water that is not currently used for potable water. The energy source for this thermal desalination process will be low pressure geothermal steam which is a currently underutilized alternative energy resource (sometime referred to as waste heat) at the Project site. The Project also will demonstrate environmental benefits, including mitigation of contaminant-laden brines by injection in deep geothermal wells, removing surface water contaminants, and beneficially recharging the geothermal aquifer.

Brine management is an essential study component with three potential benefits - aquifer recharge, safe contaminant discharge, and revenue from marketable salt extraction. Sulfate salts concentrated in the brine are likely to cause mineral scale in the injection well bore or in nearby strata, potentially blocking the well. It will be necessary to selectively extract sulfate salts from the brine prior to injection to maintain the well. It may also be possible to extract these salts in sufficient purity to yield marketable products such as sodium sulfate and gypsum. This study component will test brine management processes in the lab and field and evaluate the economic and environmental benefits of salt extraction and brine injection.

Technology developed in the VTE Demonstration Project can be applied to produce potable water in other regions with an impaired water source and a heat source that can be converted into steam to drive a VTE process. To this end a spreadsheet based planning tool will be created to evaluate the benefits and costs of co-generating water

supplies using various heat sources. Net benefits will be evaluated including capital and operating costs, proximity, quality, and quantity of impaired water sources, and the comparative value of water and power.

The proposed VTE Demonstration Project is based on a VTE Pilot Project presently operating at the site. The Project will leverage existing VTE desalination equipment, an existing geothermal power plant, the VTE pilot plant, and the accompanying plumbing and electrical systems in order to continue the research as a scalable, engineering design-scale “demonstration” facility.

The contractual arrangements needed for this project are already in place in the form of a Cooperative Agreement (#04-FC-81-1030) between Reclamation and Sephton Water Technology, a Cooperation Agreement between Sephton Water Technology and CalEnergy Operating Corporation, and a Letter of Agreement between Reclamation and Lawrence Livermore National Laboratory. These “contracts” were awarded competitively through the Federal bid process and can be executed for the proposed Project by modifying the Statement of Work and Period of Performance prior to the Notice to Proceed.

Grantee: **Municipal Water District of Orange County**
 Entity Type: **Water District**
 Project Title: **Test Slant Well - Pilot Plant Treatment and Testing Phase**
 Project Type: **Pilot/Demo - Seawater**

Total Project Cost: **\$4,171,226**
 Requested Funds: **\$1,500,000**
 Awarded Grant: **\$1,500,000**

Assembly District: **73**
 Senate District: **35**
 Congressional District: **48**

County: **Orange** City: **Dana Point**
 Latitude: **33 27 50 N** Longitude: **117 41 01 W**

Project Summary:

MWDOC is proposing this Pilot Plant Treatment and Testing Project to advance desalination treatment technologies most applicable for saltwater produced from a subsurface slant "beach well". This work is the next step in determining the cost-effectiveness of utilizing subsurface intake well technology for ocean desalination feedwater supply. A test slant well was recently fully permitted and successfully constructed into an offshore aquifer at Doheny State Beach. This proposed follow-on work is the next step in our efforts to determine the overall feasibility of utilizing novel slant intake "beach wells" for ocean desalination feedwater supply. The test slant well was funded in part under DWR's 2005 Prop 50 Desalination Program.

Key issues that remain to be addressed are the efficacy of natural particulate filtration provided by a slant well intake over an extended period of time and the control or pretreatment of naturally occurring dissolved iron and manganese in the extracted water. An extended water quality evaluation, pretreatment and chemical control investigation, membrane testing, and material corrosion study are proposed. If proven effective, a subsurface intake system would have significant positive impacts for other coastal areas where suitable near-shore alluvial formations are present. In addition, subsurface systems provide significant benefits such as avoidance of entrainment/impingement and ocean construction impacts as well as providing protection against shock loading in the open ocean due to red tides, urban runoff, oil spills, etc.

MWDOC has eight overall goals and objectives for the Pilot Plant Treatment and Testing phase:

- Determine the appropriate well casing/screen material to minimize corrosion/biofouling damages.
- Evaluate water quality over an extended pumping period, including evaluation of natural filtration benefits, the nature, speciation and reaction chemistry of dissolved iron and manganese present in the produced water, and monitor levels of naturally occurring marine aquifer/groundwater bacteria.
- Evaluate methods to control oxidation of dissolved iron and manganese, through maintenance of anoxic conditions with nitrogen blankets and reducing agents.
- Evaluate pretreatment methods to remove iron/manganese in feedwater.
- Evaluate RO operating conditions, cleaning techniques, and RO sizing for the pretreatment methods.
- Evaluate advanced membrane technology, including newly developed nanostructured fouling-resistant membranes (developed at UCLA), for effectiveness and biofouling control, that may be most applicable to subsurface intake feedwater.
- Determine waste concentrate treatment/conditioning for co-disposal with wastewater disposal via an existing ocean outfall; evaluate effects on suspended solids in the secondary effluent; and evaluate mixing ratios and plume dispersion.
- Evaluate product water post-stabilization/conditioning, considering corrosion, disinfection, potential effects on recycling, and consumer acceptance.

Subsurface slant well intakes for reverse osmosis (RO) seawater desalination plants have the potential to reduce pretreatment and RO operating costs and to avoid adverse environmental impacts associated with conventional open water intakes. To realize these potential benefits, additional investigation of subsurface well intake water quality, treatment processes, operational controls, and waste concentrate handling as proposed in this grant application are required.

Grantee: **City of Avalon**
 Entity Type: **City**
 Project Title: **Catalina Large Diameter Membrane SWRO Energy Reduction Project**
 Project Type: **Pilot/Demo – Seawater**

Total Project Cost: **\$3,637,500**
 Requested Funds: **\$1,500,000**
 Awarded Grant: **\$1,000,000**

Assembly District: **27**
 Senate District: **54**
 Congressional District: **46**

County: **Los Angeles** City: **Catalina Island**
 Latitude: **33.382 N** Longitude: **118.433 W**

Project Summary:

Build, Own, Operate Transfer (BOOT) a 200,000 gallons per day (GPD) skid mounted seawater reverse osmosis (SWRO) desalination system with greatly reduced specific energy consumption, providing potable water to the City of Avalon. This system is to be installed in parallel with Southern California Edison's existing seawater desalination plant on Catalina Island. The system combines the technology advances of high efficiency pumping and energy recovery, and large-diameter parallel-flow membranes. Specifically this project will include the design, manufacture, installation, operation and monitoring for two years to demonstrate the electric powered VARI-RO Integrated Pump & Energy Recovery (IPER) method, the DesalNATE 3-Channel Membrane System, and the KOCH MegaMagnum membrane assemblies. A further objective will be to use the resulting cost, performance and reliability data to prepare designs and evaluation criteria for the future systems that would be suitable for large-scale desalination facilities in California and elsewhere.

The City of Avalon is pleased to submit this PROP 50 proposal to reduce the cost of ocean water desalination at the existing 200,000 gallons per day (GPD) Catalina Seawater Desalination Facility. At the same time this project will help bring high efficiency pumping and energy recovery, and large-diameter parallel-flow membrane technology advancements to the desalination industry. These advancements offer the potential to provide a significant reduction in capital cost and electricity use for ocean water desalination. Electricity on Catalina Island is generated using Diesel engines, which are close to the City of Avalon. Using less electricity for desalination lowers the air pollution per 1,000 gallons of fresh water produced. These technology advancements addresses several of the issues stated in the solicitation, including: 1) Energy efficiencies, 2) Alternative energy sources, 3) Improved process design, and 4) Advancing desalination technology.

The project objectives will be to make ocean water desalination more cost effective as a supplemental water supply for Catalina Island, other California locations, and other water supply needs around the world. Specifically, a new skid mounted 200,000 GPD seawater desalination unit will be installed at the existing facility. The new unit will be run in parallel with the existing units, so that full output can be produced from either the new or the existing, but not at the same time — due to limited capacity of the existing seawater wells.

To accomplish this, we have engaged the VARI-RO/DesalNATE Team to combine three next generation seawater desalination technologies: 1) highly efficient Integrated Pump Energy Recovery (IPER), 2) three-channel feed flow to the membranes, and 3) large diameter membrane modules. These technology advancements allow more ocean water to be desalted in a smaller foot print. This includes reducing the plant floor area needed, shortens the high pressure piping runs, and will make the system more accessible for routine servicing of the membranes, pump and valves. The potential capital cost savings and lower electricity requirement have allowed a unique Commercial Supplier team to be assembled to

support the City of Avalon proposal. The key partners to accomplish this includes:

- Southern California Edison, Water and Electric Utility for the city of Avalon
- VARI-RO Inc., Integrated Pump & Energy Recovery Manufacturer
- DesalNATE Inc., Desalination System Supplier/ Major Investor

In addition, The Environmental Protection Agency, Environmental Technology Verification Program selected National Science Foundation, an independent third-party-accredited organization, to verify water treatment technologies. The Drinking Water System Center will provide monitoring of water quality and other important parameters. The qualifications of the primary team members, their supporting contractors and the organization structure and functions are provided in detail.

The primary objectives of this project will be to design, manufacture, install, operate and demonstrate the electric powered VARI-RO Integrated Pump & Energy Recovery (IPER) method, the DesalNATE 3-Channel Membrane System, and the KOCH MegaMagnum membrane assemblies. A further objective will be to prepare preliminary designs and evaluation for the future system that would be suitable for large-scale desalination facilities in California and elsewhere.

The **project scope** will be to demonstrate the following technology advancements:

High Efficiency Pumping and Energy Recovery. A pumping and energy recovery method known as VARI-RO Integrated Pump & Energy Recovery (IPER) will be demonstrated in comparison to the existing SWRO array configuration. This electric powered method has been previously Studied, Pilot Plant Tested, and Evaluated under a program funded by the U. S. Bureau of Reclamation (USBR), and a broad coalition of public and private organizations. These projects showed that this method can provide a viable, reliable, and cost-effective solution to reduce energy costs.

Large-Diameter Parallel-Flow Membrane Technology. There are two components to this technology. The first component is characterized as a “**Third Channel Fresh-Feedwater Injection System.**” **The proposed technology is manufactured by DesalNATE.** This technology allows the use of large diameter membranes, of sixteen inches or larger, significantly increasing the amount of product water over conventional membrane technologies. The technology may also be implemented in systems with smaller membrane diameters and can, therefore, be used to retrofit existing 8” systems.

The other component is utilizing a large diameter SWRO element commonly known as a MegaMagnum. The Koch MegaMagnum SWRO membrane will be tested during this study. These large diameter elements (16 or 18” diameter by 60” long versus the conventional 8” x 40”) have previously been demonstrated for brackish water reverse osmosis (BWRO) desalination under a program sponsored by the Metropolitan Water District (MWD) of Southern California. This work has shown that large diameter elements can reduce the present logistics nightmare, and space requirement, for large-scale desalination facilities.

The two year test and evaluation phase will provide the information needed to determine how accurately the predictions of energy use per 1,000 gallons were, how accurate the capital cost projections matched the installed cost, and how the predicted operation and maintenance costs were realized in a real operating system. The ability to predict will be important, because it will allow the benefits of further technology improvements to be accurately assessed.

More importantly, the actual electricity used per 1,000 gallons, capital and O&M costs will allow other desalination installation planners to evaluate the tested system against other commercially available systems, such as centrifugal pump-Pelton wheel, centrifugal pump-work exchanger energy recovery, centrifugal pump-pressure exchange. Careful data collection planning, execution and management are critical to the success of this program. The data base developed by this program will set the bench mark for the technology demonstrated on Catalina Island for Avalon. The data will show the overall benefits and challenges that must be overcome so that the promise of these technologies can be correctly applied for the major ocean-water desalination-projects that are now being planned for California.

Grantee: **Indian Wells Valley Water District**
 Entity Type: **Water Agency**
 Project Title: **Pilot Testing of Zero-Liquid-Discharge Technologies Using Brackish Groundwater for Inland Desert Communities**
 Project Type: **Pilot/Demo - Brackish Water**

Total Project Cost: **\$1,189,000**
 Requested Funds: **\$578,500**
 Awarded Grant: **\$578,500**

Assembly District: **32**
 Senate District: **18**
 Congressional District: **22**
 County: **Kern** City: **Ridgecrest**
 Latitude: **35 43 30** Longitude: **117 50 00**

Project Summary:

Located in the northern part of the Mojave Desert and serving more than 27,000 people approximately 8 million gallons per day of potable water, the Indian Wells Valley Water District (IWWVD) is a true in-land water agency. With groundwater as the only water source in the area, IWWVD's alternatives for developing new water supplies are limited, and new sources of low salinity water are not available.

Growth in the area and the expansion of the neighboring China Lake Naval Air Weapons Station (announced in 2005) are placing greater demands on the water resources in the area. Other towns and agencies to the north, east, and west have similar water issues.

In an effort to evaluate the potential to desalt brackish water from an area known as the Northwest Well Field (NWWF) and produce 3,000 AF per year of new potable water, the IWWVD conducted a yearlong feasibility investigation. The investigation determined that:

1. Several water quality parameters need to be addressed.
2. Technologies are available to treat the brackish groundwater to potable standards.
3. A very high water recovery (zero-liquid-discharge - ZLD) system should be employed to manage and treat concentrate streams in a neighborly and environmentally friendly manner.
4. Pilot testing should be carried out to determine the technical feasibility of the primary and secondary desalting processes identified and confirm the water recovery levels that can be achieved.

IWWVD is now ready to embark on the pilot-testing phase of this project. The source water and the site have been characterized. Seven letters of support for this project have been obtained from neighboring agencies and interested parties. The reason that these parties are interested is that they understand the need for developing a new water source in this water scarce region. Expanding the project to a regional facility may be a possibility.

The project has several goals, including confirming the water recovery that can be obtained by the primary (reverse osmosis - RO) and secondary (electrodialysis reversal - EDR) desalting steps, on this challenging brackish (TDS = 2,300 mg/L) well water.

The goals of the project and the project itself are in step with the objectives of the funding program. In addition to creating a new source of potable water while furthering the use of economically acceptable desalination technologies in a region that is limited to groundwater as its only water source, this project will advance desalination technology by treating a challenging water source and evaluating a novel "reversible" RO plant configuration.

The scope of this project includes setting up and testing a two-stage (primary and secondary desalting processes) pilot plant for six-months on representative well water from the NWWF. The membrane performance of the reversible RO pilot will be evaluated and compared to conventional systems and product water recovery will be optimized. On-site testing will include bench tests to determine pretreatment requirements; treatment for the removal of selenium, arsenic and uranium from the concentrate stream; evaluation of calcium carbonate for conditioning permeate streams; and the confirmation of performance criteria for a brine concentration step.

This project is focused on the ZLD requirements of this inland community, where the costs of limited water supplies are hard to quantify. The financial benefits of this project are realized by the fact that for every 1-percent increase in the primary RO plant recovery that can be obtained on this high-silica groundwater (silica ~45 mg/L), there will be about a 3-percent reduction in the size of the downstream brine concentrator. This translates into about a 3-percent reduction in the electrical power consumption of the brine concentrator, a similar reduction in the final volume of concentrated brine that would flow to a small evaporation pond, and about a 2-percent reduction in the capital cost of the brine concentrator.

These significant benefits alone justify testing the technical aspects of the proposed work. But, more importantly, finding a ZLD solution for the inland area of the Indian Wells Valley brings the significant benefit of a new source of potable water for this land-locked community that has no option but to manage and treat desalting concentrate streams if it is going to exploit its brackish water resources.

Grantee: **Board of Water Commissioners of the City of Long Beach**
 Entity Type: **Water Department**
 Project Title: **Mitigating Water Quality Effects of Desalinated Seawater**
 Project Type: **Pilot/Demo - Seawater**

Total Project Cost: **\$2,270,000**
 Requested Funds: **\$1,000,000**
 Awarded Grant: **\$1,000,000**

Assembly District: **54**
 Senate District: **27**
 Congressional District: **37**

County: **Los Angeles** City: **Long Beach**
 Latitude: **33.75278** Longitude: **-118.11028**

Project Summary:

This document presents the Proposition 50 Application for the Long Beach Water Department's (LBWD's) research and demonstration project on Mitigating the Water Quality Effects of Desalinated Seawater (Project). This Executive Summary provides highlights of the Project's (1) relevance and importance, (2) technical and scientific merit, (3) feasibility and environmental impacts, (4) work plan, (5) public outreach/environmental justice components, (6) applicants and cooperators, and (7) costs and benefits.

Relevance and Importance. The purpose of the Project is to determine how to best integrate desalinated seawater into the distribution network for a typical California municipality. The Project will develop a field demonstration on existing piping of the City of Long Beach (City). These piping materials are typically found throughout California. By focusing on the delivery of high-quality desalted seawater to the customer's tap, the Project will provide the last piece of the puzzle required to make desalted seawater a viable component of the water resources portfolio for municipalities along California's coast.

Technical/Scientific Merit, Innovation, and Technological Advancement. The Project provides unique opportunities to advance the state-of-the-art in post-treatment for seawater desalination in several major areas. (See adjacent graphic.)

Project Readiness, Feasibility, and Environmental Mitigations and Benefits. The Project is a logical extension of the LBWD's three-phase research and demonstration project, which includes a 9,000 gallon per day (gpd) pilot scale plant completed in 2001 (Phase 1), a 300,000 gpd prototype desalination plant currently underway (Phase 2), and a full-scale seawater desalination demonstration plant up to 10 million gallons per day (mgd). No adverse environmental impacts are anticipated from the proposed Project. In fact, the Project will protect the existing distribution system, protect public health, eliminate negative impacts of corrosion, mitigate water quality effects, tap the significant potential of the ocean as a water supply source, defer or eliminate the need for development of other surface water sources, such as lakes and rivers, provide time for diminished groundwater resources to be replenished, and ensure a cost-effect, high-quality water supply for the public.

Project Tasks, Deliverables, Monitoring, and Assessment. This application presents a fully developed Project Work Plan broadly divided into three phases:

- **Data Collection and Bench-scale Study.** Tasks will include an analysis of permeate water quality, a desk-top evaluation of corrosion control, characterization of the existing distribution system water, and bench-scale evaluation of corrosion control, disinfection stability, and DBP formation.
- **Simulated Distribution System Pipe Tests.** Tasks will include construction of a demonstration-scale distribution system (pipe racks), corrosion coupon study, and evaluation of demonstration-scale effects.
- **Disinfection Studies.** Tasks will include evaluation of the effects of bromide concentration on chlorination and chloramination, monitoring the stability of disinfectant residuals, and monitoring DBP formation in blended waters.

Outreach, Information Sharing, and Environmental Justice. Program results can be easily integrated with LBWD's ongoing, proactive public outreach program, which includes publications, Water Ambassador Program, school/water education programs, community relations, Water Awareness Month, and media/internet activities. The project also is compatible with environmental justice goals.

Qualifications of the Applicants and Cooperators. LBWD has been proactively pursuing seawater desalination as an addition to its water supply portfolio for more than five years. During this time, the Department has been joined by several supporters and/or funding partners. These agencies include the Los Angeles Department of Water and Power, the Metropolitan Water District of Southern California, the University of California at Los Angeles, and the United States Bureau of Reclamation.

Costs and Benefits. The cost for the proposed demonstration project is approximately \$2.3 Million. However, the successful development of corrosion control methods (to minimize the occurrence of pipe replacements resulting from corrosion) and ensuring the stability of disinfectants would minimize the occurrence (prevent the need for additional treatment requirements or modifications) could potentially save millions of dollars in operation and maintenance costs for agencies and utilities interested in implementing seawater desalination. This Project will ensure that a successfully commissioned seawater desalination plant could operate reliably and efficiently, delivering high-quality water to the general public.

State-of -the-Art Research Summary

A. Corrosion Control.

- Identify optimal corrosion control treatment
- Assess applicability of commonly-used corrosion
- indices
- Evaluate impact on pipe materials

B. Disinfection of Desalinated Seawater.

- Assess various blending ratios.
- Document DBP formation potential.
- Identify ways to maximize water stability.

C. Aesthetics.

- Evaluate the taste and public acceptance of desalinated seawater

D. Other.

- Evaluate scale-up effects.
- Estimate life—cycle costs.
- Prepare Final Report.

Grantee: **City of Camarillo**
 Entity Type: **City**
 Project Title: **City of Camarillo Brackish Water Desalination Pilot Study**
 Project Type: **Pilot/Demo - Brackish Water**

Total Project Cost: **\$767,744**
 Requested Funds: **\$383,872**
 Awarded Grant: **\$383,872**

Assembly District: **37**
 Senate District: **19**
 Congressional District: **24**

County: **Ventura** City: **Camarillo**
 Latitude: **34 14 40** Longitude: **119 01 13**

Project Summary:

The proposed project will pilot test the use of high-pressure membrane treatment technologies (reverse osmosis (RO) and nanofiltration (NF)) for desalination in conjunction with low-pressure membrane treatment technologies (microfiltration (MF) or ultrafiltration (UF)) for pretreatment to recover currently unusable brackish groundwater from the North Pleasant Valley Groundwater Basin in the City of Camarillo (City). This new source of water supply (600 acre-feet annually) is consistent with State and regional water management plans and provides statewide benefits by reducing Southern California's imported water needs. It provides local benefits by improving water supply reliability and by diversifying supply sources and assisting in the recovery of this important water supply groundwater basin.

The basin brackish groundwater contains total dissolved solids concentrations of approximately 1500 mg/L and iron and manganese concentrations of approximately 250 ug/L and 150 ug/L, respectively. These latter two contaminants represent a special challenge to the use of high-pressure membrane treatment processes. Effective pretreatment must be used to control the scaling potential associated with these two parameters. Although elevated TDS, iron, and manganese are common groundwater contaminants for which there is significant treatment experience in the water treatment industry, the City proposes to test an innovative treatment process to optimize the removal of these contaminants to acceptable levels in a cost-effective and environmentally sensitive manner. Subsequently, because these three contaminants are so pervasive, the pilot work conducted by the City has the potential to benefit numerous other utilities with desalination applications throughout the State of California.

Significant features associated with this pilot testing project include unique *pretreatment*, the testing of *new membrane elements*, and *emerging contaminant identification and treatment*.

Pretreatment. The City of Camarillo's proposed treatment process features a number of innovative elements, beginning with the use of chlorine dioxide to oxidize iron and manganese to precipitate form for removal using membrane filtration (MF or UF) or granular media filtration. This novel approach of utilizing an oxidation process prior to two-stage membrane treatment (i.e., MF or UF for pretreatment and RO or NF for desalination) has been tested in a very limited number of applications. This proposed process can eliminate the need to add a quenching agent (needed to protect the membranes when using other types of oxidants), as well as help control membrane fouling, thereby resulting in fewer chemical cleanings, less chemical use, and longer membrane life.

The City's proposed process for generating chlorine dioxide on-site has several environmental advantages including reduction of chemical usage for membrane desalination pretreatment, on-site generation of caustic (a by-product of the electrochemical chlorine dioxide generation process) for post-treatment pH and stabilization, and a potential reduction in chemical usage for periodic membrane cleaning.

New Membrane Elements. Because the levels of TDS, iron, and manganese may not require high rejection to meet drinking water standards and match imported surface water quality, the City will test the latest NF membranes and ultra-low- pressure RO membranes from a number of manufacturers to meet its water quality objectives while minimizing energy requirements and operating costs.

Emerging Contaminant Treatment. Because the North Pleasant Valley Groundwater Basin is situated below a mix of both industrial and significant agricultural operations, its groundwater supply may be subject to influence by emerging contaminants that the City's proposed innovative treatment process might remove. The City will monitor for targeted emerging contaminants throughout the course of its piloting to determine the effectiveness of the treatment processes. These data will be useful for other utilities with similar emerging contaminants and treatment challenges throughout California.

Although the combination of technologies to be piloted in the City's pilot testing program is unique with innovative advantages, the major component processes – oxidation using chlorine dioxide generated on site, MF/UF and media filtration, and RO/NF – are well-established for their respective applications relative to the overall treatment scheme. Thus, the focal point of the City's piloting program is to use proven treatment processes in a creative combination to demonstrate clear cost savings and environmental benefits over more conventional means of brackish water desalination.

The compilation of these data will enable the City to identify the optimum pretreatment process and operating conditions for cost-effectively meeting its water quality and quantity objectives at full scale. Because the data should be largely scalable, other utilities will be able to evaluate the technical feasibility and cost effectiveness of the City's treatment process for their own facilities of different capacity as applied for similar water quality.

Grantee: **Montara Water and Sanitary District**
 Entity Type: **Special District**
 Project Title: **Subsurface Intake Filter Technology Evaluation**
 Project Type: **R&D - Seawater**

Total Project Cost: **\$271,213**
 Requested Funds: **\$135,000**
 Awarded Grant: **\$135,000**

Assembly District: **19**
 Senate District: **8**
 Congressional District: **12**
 County: **San Mateo County** City: **Montara**
 Latitude: **37.534 N** Longitude: **122.517 W**

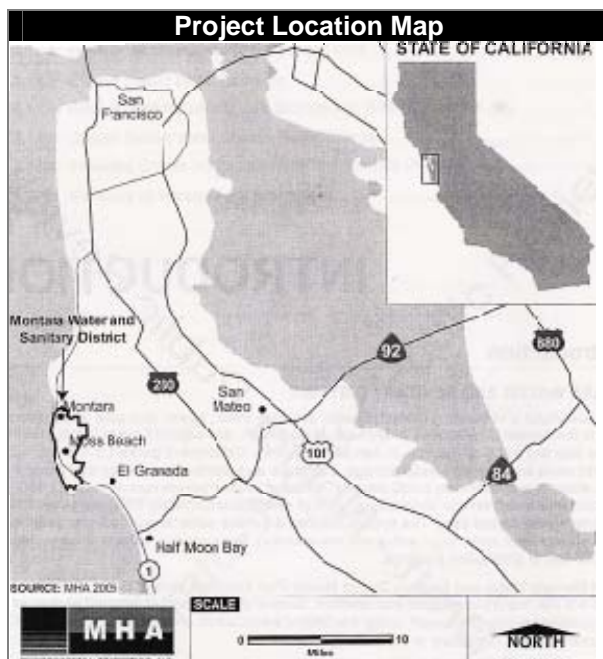
Project Summary:

Project Goal

The goal of this Research and Development Project (R&D Project) is to evaluate the use of subsurface intake filter (SIF) technology as a feed water source for the Montara Water and Sanitary District's (District or MWSD) proposed seawater desalination plant. This R&D Project would also investigate the use of an existing abandoned marine pipe as part of the feedwater conveyance system from the SIF's to the desalination plant and the potential for alternative energy sources. The District proposes a 19-month R&D Project to analyze the feasibility of SIF's as water supply to a desalination facility.

Project Background

MWSD provides water, sewer, and trash disposal services to the coastal communities of Montara, Moss Beach, and adjacent areas located north of Half Moon Bay and south of Pacifica, in San Mateo County, California (see map below). The District owns and operates water storage, treatment, and distribution facilities to serve a population of 4,550 through 1,660 active service connections. The water served comes from one surface source, Montara Creek, and several groundwater wells that withdraw water from the Montara Creek and Denniston Creek groundwater basins.



The District's top priority is to provide its existing customers with a reliable water supply. With long-standing limitation on surface water extraction and insufficient groundwater sources, the District's water deficiency issue is expected to persist and intensify in the near future. The District's long-term water reliability plan outlined in the 2004 Water System Master Plan Update and 2005 Addendum to the Master Plan calls for diversifying the community's water sources. After much research and evaluation, MWSD chose to pursue evaluating desalinated Pacific Ocean water as a potential supplemental supply source.

The proposed MWSD's R&D Project aims at specifically addressing the following water desalination issues:

- Developing better feedwater pretreatment processes and strategies by utilizing subsurface intake filters
- Contributing to research on value and limitations of SIF's for feedwater intake
- Developing strategies for brine/concentrate management
- Testing technologies to reduce entrainment and impingement impacts
- Incorporating opportunities for energy efficiencies and application of alternative energy sources and combined energy and desalination technologies, specifically offshore ocean wave energy
- Incorporating an improved desalination process design, to include but not limited to: membrane processes and thermal processes
- Contributing to other applied research investigations aiming at refining/advancing desalination technology with respect to low impact SIF installation methods

Development of a complementary water supply for this small California coastal community would contribute to mitigating potential adverse environmental impacts of depleting groundwater aquifers, and endangerment of public health and safety from inadequate emergency supply and/or vulnerable water quality of existing sources. In addition, this R&D Project will examine the benefits of developing alternative potable water supplies consistent with the San Mateo County Groundwater Management Plan. This approach will serve as a model for many California coastal communities challenged by similar issues.

The District is fully committed to the investigations of the potential development and use of alternative water supply sources from desalination. With limitation on surface water diversion and insufficient groundwater sources, The District's water supply barely meets current demands and often requires mandatory conservation measures. The current maximum day production is only 43 percent of the demand. The District needs to replace approximately 60 percent of its current water supplies that derive from ground sources of inadequate quality. Water quality impairment results from elevated levels of iron and manganese; nitrate and 1,2,3-trichloropropane (TCP) contamination; and failure to meet the action level for copper. The District's water deficiency issue is expected to persist and intensify in the near future.

The District's water system currently has a moratorium on new water service connections. The District has successfully advocated specific revisions to San Mateo County's Local Coastal Program to provide a reserve for priority connections based upon failed private wells within the service area so that, once additional water supplies become available, existing well owners whose wells fail might have an opportunity to connect to the District's system on a priority basis.

The proposed R&D Project is intended not only to support customer demands in terms of water quality and quantity, but serves to safeguard the public health and safety of the community at large, such as access to an adequate emergency reserve and fire fighting supply while protecting fragile coastal environmental resources.

Grantee: **Sweetwater Authority**
 Entity Type: **Water District**
 Project Title: **Zero Discharge Solar Distillation Research and Development Project**
 Project Type: **R&D - Brackish Water**

Total Project Cost: **\$990,800**
 Requested Funds: **\$481,500**
 Awarded Grant: **\$481,500**

Assembly District: **79**
 Senate District: **40**
 Congressional District: **51**

County: **San Diego** City: **Chula Vista**
 Latitude: **33 N** Longitude: **117 W**

Project Summary:

This application is to support the research and development of a Zero Discharge Solar Distillation project, also known as Solar Distillation Loops (SDL). The purpose of the research is to determine if the SDL system can use brackish concentrate discharge from a reverse osmosis (RO) facility to produce potable water and a more concentrated brine discharge using ambient solar energy. If successful, this technology could provide inland communities with access to brackish groundwater as an alternative source of water with a means to manage the brine discharge in a cost effective manner. Additionally, it could allow Sweetwater Authority (Sweetwater) to minimize the amount of brine discharged from the district's Richard A. Reynolds Groundwater Desalination Facility (Desalination Facility), which currently discharges all brine concentrate to the Sweetwater River and ultimately to San Diego Bay.

The SDL project is relevant and inline with the objectives of this funding program because it would determine whether potable water could be produced from RO brine concentrate. The technology creates a process in which solar distillation is accelerated using the natural thermal gradient near the ground surface and below grade. The basis of SDL technology is a closed loop of drainage pipe, half of which is installed on the surface and half of which is buried below grade. Each solar distillation loop contains solar powered fans that circulate air through the loop. During daylight hours, the air space in the pipe rapidly reaches water vapor saturation. The solar powered fans subsequently force this water vapor below ground where the air is cooled, and the water vapor condenses. The brine concentrate in the surface section of the loop is replenished and removed for disposal to an evaporation pond and ultimately to a landfill.

Sweetwater's project is proposed as a three-year project to focus on the development of a practical application of SDL technology. In the first year, the system would be installed and operated, and distillate production would be monitored. In subsequent years, methods of increasing the thermal gradient between subsurface and surface piping would be implemented, and distillate production would be monitored and compared to the baseline system. Extensive experience with owning, operating, maintaining and constructing water supply systems makes Sweetwater uniquely qualified to undertake the SDL research and development study. Furthermore, Sweetwater has engaged the USGS to provide technical assistance on the project. As SDL technology's patent applicant, Dr. James Constantz of the USGS will provide technical oversight as well as data analysis services.

The information and data produced during the research will be disseminated to interested water and wastewater agencies through the preparation and publication of technical papers and through presentations at technical seminars. Informing the general public about Sweetwater Authority's programs, projects, and studies is part of the district's ongoing communications program, and outreach to the community is important to Sweetwater. Sweetwater Authority is a local water resources leader and is committed to keeping the public informed of innovative and beneficial programs.

Sweetwater's efforts to further this technology are consistent with the San Diego region's trend toward increased use of groundwater and seawater desalination. The technology would support Sweetwater's goal of reducing the district's reliance on imported supplies and diversifying its local supplies to maximize reliability and minimize costs to consumers. Sweetwater and the proposed groundwater desalination project are compliant with the Groundwater Quality Monitoring Act of 2001 (AB 599). Sweetwater participated in the Groundwater Ambient Monitoring Assessment (GAMA) program in 2005. This program was implemented by the California State Water Resources Control Board to satisfy the Groundwater Quality Monitoring Act of 2001. Sweetwater is committed to continuing our relationship with the GAMA project in the future.

Grantee: **West Basin Municipal Water District**
 Entity Type:
 Project Title: **Critical Raw Water Quality Issues Unique to Seawater: Marine Phytoplankton Blooms, their Associated Biotoxins, and Transient Urban Stormwater Inputs**
 Project Type: **R&D - Seawater**

Total Project Cost: **\$1,245,800**
 Requested Funds: **\$496,483**
 Awarded Grant: **\$496,483**

Assembly District: **42, 47, 51, 52, 53, 54, 55**
 Senate District: **23, 25, 26, 28**
 Congressional District: **30, 33, 35, 36, 37, 46**
 County: **Los Angeles** City: **El Segundo**
 Latitude: **33.91 N** Longitude: **118.42 W**

Project Summary:

Treatment requirements for the seawater reverse osmosis (SWRO) process when treating Pacific Ocean seawater are currently being studied and defined through various efforts throughout the state, including several supported by the CA Proposition 50 program. West Basin Municipal Water District has been a leader in research and development of integrated membrane seawater desalination systems (MF or UF followed by RO) and investigating the operational and water quality implications of these treatment processes. WBMWD has operated a multi-faceted pilot facility for over three years, a facility that includes:

- A USFilter CMF-S MF pretreatment unit,
- A Zenon ZW-1000 UF pretreatment unit,
- Two Arkal pretreatment strainer units,
- Three (3) trains of RO elements, and
- A corrosion pilot plant.

This facility uses both pre- and post-condenser sourcewaters from an open ocean intake at the NRG power generating facility in El Segundo, CA.

Over the course of this comprehensive pilot testing program, WBMWD self-funded two areas of research which are unique to seawater: 1) the impact of transient stormwater runoff on seawater water quality at the El Segundo intake, and 2) the dynamics of phytoplankton blooms ("red tide") and the production and removal via RO of domoic acid, a toxic byproduct of algae blooms. The limited data collected regarding these two phenomena are critically important to the development of seawater desalination because:

- They are issues unique to seawater and relatively unknown,
- They are not addressed in current regulatory framework (consisting of Sanitary Surveys and Sourcewater Assessments),
- They represent important permitting issues related to protection of public health, and
- They present operational challenges that have direct impacts on the cost of treatment (sizing and O&M) of seawater desalination, an already relatively expensive supply.

WBMWD, in conjunction with the University of Southern California, proposes to use their existing pilot facility and preliminary knowledge of the occurrence of these two phenomena to develop and conduct a comprehensive, two-year monitoring program of:

1. stormwater impacts on the SWRO treatment process and resulting permeate water quality, and
2. marine phytoplankton and biotoxin production impacts on the SWRO process and resulting permeate water quality.

This program will develop real-time monitoring surrogates and will utilize state-of-the-art technologies to demonstrate the public health and operational significance of these events. The algal toxin information generated by this proposed project will be completely new not only in the context of seawater desalination, but in the context of basic research into marine biology and oceanography.

This proposal addresses sourcewater quality and treatment issues that, according to the PSP, address the issues identified by the Task Force for project eligibility under numbers 1, 7, and 8. This project will identify and assess sourcewater quality and treatment issues that impact:

- selection of feedwater pretreatment technologies,
- selection of RO membrane technologies,
- operating strategies,
- membrane cleaning strategies,
- membrane replacement,
- permeate water quality,
- cost of treatment.

Grantee: **Colorado School of Mines**
 Entity Type: **University**
 Project Title: **Novel Hybrid Membrane Desalination Process with Minimal Pretreatment and Concentrate**
 Project Type: **R&D - Brackish Water and Seawater**

Total Project Cost: **\$1,071,702**
 Requested Funds: **\$499,957**
 Awarded Grant: **\$499,957**

Assembly District: **65**
 Senate District: **37**
 Congressional District: **49**
 County: **Riverside** City: **Sun City**
 Latitude: **33.42 N** Longitude: **117.11 W**

Project Summary:

California, like many other parts of the country and the world, faces great challenges in meeting future potable water supply needs. Additional water resources are needed to support population growth and economic expansion. Seawater desalination has become a common practice to supply the growing demand for water in areas with access to the sea. Brackish water desalination is being investigated as a source of potable water in inland regions. Advanced water treatment processes such as reverse osmosis (RO), nanofiltration (NF), electrodialysis (ED), and distillation are effective for producing potable water from seawater and brackish water. However, these processes still facing several drawbacks including membrane fouling and scaling, limited recovery, energy-intensive operation, and negative environmental impacts.

Membrane contactor processes are an emerging class of membrane separation processes that utilize concentrated brines or low grade heat sources to separate liquid streams. Their low energy consumption and versatility of application make them an attractive option for pretreatment and post-treatment for desalination processes, and in special cases, for the desalination process itself. Combinations of membrane contactor processes and combinations of these processes with traditional pressure-driven membrane processes can further emphasize their advantages. In the proposed investigation, forward osmosis (FO) and membrane distillation (MD) are the two membrane contactor processes to be studied alongside traditional pressure-driven membrane desalination processes such as NF and RO.

FO is an osmotic-driven membrane process that uses osmotic pressure differential across a semi-permeable membrane, rather than hydraulic pressure differential (as in RO), as the driving force for transport of water through the membrane. The FO process results in concentration of a feed stream and dilution of an osmotic agent (i.e., a draw solute). The PIs of the current proposal have been studying various novel applications of FO, including direct potable reuse of wastewater, desalination of brines from brackish water desalting, and direct desalination of seawater. When used for seawater desalination, the proposed hybrid non-pressure system will almost completely prevent entrainment and impingement problems associated with water intakes and will eliminate most of the problems encountered during brine disposal. The novel pretreatment and brine minimization techniques that will be thoroughly studied in this project could offer substantial energy and resource savings for conventional desalination processes. Further, the techniques proposed will substantially mitigate the environmental impacts associated with desalination practices. Existing desalination plants could be retrofitted with minimal capital costs. Only minor plumbing reconfiguration and installation of few components would be necessary to achieve substantial savings. In a recent preliminary FO study conducted by the PIs, it was shown that greater than 90% water recovery can be achieved during desalination of brackish water.

MD is a thermal separation process that combines simultaneous mass and heat transfer through a hydrophobic microporous membrane. Mass transfer in this process is carried out by evaporation of a volatile solute or a volatile solvent (water), when the solute is non-volatile. The driving force for mass

transfer in the process is vapor pressure difference across the membrane. A unique MD method was developed and tested by the PIs that enables enhanced distillation of seawater by MD at relatively low feed temperatures.

In the current proposal, three academic institutions that are leaders in the research of membrane contactor processes, are joining expertise to investigate the synergetic effects of combining membrane contactor processes and pressure-driven processes to enhance seawater and brackish water desalination. In the proposed research, FO will be utilized as a pretreatment and promoter of seawater and brackish water desalination. The brine from the desalination process will be further concentrated by MD. This brine then will be used as draw solution for further FO extraction of water from seawater or brackish water.

The overall goal of the proposed investigation is to develop and test a hybrid system of membrane processes that uses FO and MD as pretreatment and post-treatment for RO or NF desalination process and thereby improve the viability, efficiency, and practical application of seawater and brackish water desalination at low energy expenditure and with minimal impact on the environment. The integrated hybrid system will be challenged in the laboratory with simulated seawater and brackish water feeds and will be tested in the field for treatment of brines from desalination of brackish water at one of Eastern Municipal Water District (EMWD) desalter sites. Specifically, the main advantages of the proposed hybrid system over a stand alone desalination process such as RO, NF, electrodialysis (ED), or distillation include:

- Enhanced water recovery, and hence, less concentrate volume
- Reduced pretreatment requirements because FO is inherently less susceptible to fouling
- Energy savings (especially in the brackish water treatment scenario)
- Presence of multiple barriers to biological and chemical contaminants
- Increased flexibility because the system has the ability to desalinate a wide range of feed waters including sea water, brackish water, or any other impaired water
- Reduced environmental impact because of substantial reductions in chemicals use and substantial reductions in discharge to the environment
- Mitigation of entrainment and impingement impacts

In satisfying these objectives, the following areas of particular interest to the Desalination Task Force will be addressed: 1) better feedwater pretreatment processes and strategies including reduction or elimination of entrainment and impingement impacts, 2) technologies to reduce entrainment and impingement impacts, 3) strategies for brine/concentrate management, 4) opportunities for energy efficiencies and application of alternative energy sources and combined energy and desalination technologies, and 5) improved desalination process design, to include but not limited to: membrane processes and thermal processes.

Grantee: **University of California, Los Angeles**
 Entity Type: **University**
 Project Title: **Advanced Monitoring, Optimization, and Control Technologies for High-Efficiency Membrane Desalination**
 Project Type: **R&D - Brackish Water and Seawater**

Total Project Cost: **\$1,068,256**
 Requested Funds: **\$500,000**
 Awarded Grant: **\$500,000**

Assembly District: **42**
 Senate District: **23**
 Congressional District: **30**

County: **Los Angeles** City: **Los Angeles**
 Latitude: Longitude:

Project Summary:

At present, state-of-the-art membrane plants are designed for a specific feed water quality with significant margin of safety to avoid fouling and scaling problems. One consequence of this over-design is operation at relatively low product water recovery for seawater desalination (typically ~30-40%). Recovery in brackish water desalination is also limited (typically < 85%) due to mineral salt scaling and fouling. The above recovery limits represent technical constraints.

There are currently intensive research and development efforts to advance membrane technology to overcome these limits. A central impediment to high efficiency operation of RO plants that is yet to be addressed is the need for robust operation as plant performance is pushed to the safety margins with respect to fouling and scaling. Both feed pre-treatment requirements and RO plant operation depend on feed water quality, which can vary unpredictably during episodic events as well as diurnally, seasonally, and over longer times. At present, unfortunately, current RO plant technology is incapable of robust operability to enable continuous and efficient operation at the optimum recovery limits. New and advanced process technologies are required in order to enable RO plants to operate at high level of control, flexibility, and efficiency.

Efforts to increase plant robustness and elevate product water recovery will necessitate stringent plant optimization and controls that consider real-time monitoring of the onset of scaling and fouling throughout the various segments of the plant. *Failure to consider the detailed feed water quality and its temporal variability can result in catastrophic plant failure.*

Continuous plant operation with variable feed water quality may not be possible unless adaptive process optimization and control technologies are also utilized. Neither adaptive treatment processes nor adaptive optimization and control technologies are currently available, but will be developed within the scope of the proposed research. Clearly, a critical step towards enabling robust operation of future high efficiency membrane desalination plants is the development of real-time process monitoring, optimization and control, including state-of-the-art “hard” and “soft” sensor technologies and control algorithms for both desalination and ancillary processes. Optimal operation of RO plants will ultimately also enable more energy efficient operation at higher recovery than possible with present day desalination plant configurations and control strategies.

In order to meet the above challenge, the proposed research will focus on advancing the RO desalination process optimization and control paradigm that will rely on: (i) ex-situ sensors to detect and give early warning of the onset of scale/cake/biofilm formation; (ii) an intelligent cognitive neural network “soft sensor” system to develop meaningful relationships between variations of a feed water quality, operating conditions, and process performance; (iii) advanced process optimization and control algorithms; and (iv) an integrated web-based process monitoring and control interface. The specific project objectives are:

1. *Develop a rigorous process model for optimization and control of high efficiency, multistage desalination systems considering temporal variability of feed water quality,*
2. *Construct a laboratory-scale integrated membrane desalination test platform to enable systematic optimization and testing of high efficiency, multi-stage membrane desalination systems,*
3. *Develop and demonstrate advanced control algorithms that includes integrated virtual sensors for online optimization and control of high efficiency, multi-stage membrane desalination,*
4. *Provide rigorous student education and professional training programs membrane desalination technology, and*
5. *Disseminate research results via a rapid technology transfer program.*

A database of historical seawater quality data will be developed, as part of the first objective to include selected California coastal areas. Historical seawater quality records will be supplemented with field sampling and analysis where available and this new water quality data will be combined with the UCLA Water Technology Research (WaTeR) Center's existing RO analysis of inland brackish water quality. Next, we will develop and test a modular multi-stage laboratory desalting (MSLD) system using synthetic and real feed waters representative of California brackish waters and coastal seawater. The MSLD will enable, at the laboratory scale, the testing of integrated, multi-stage desalting operations. The system will also enable evaluation of emerging membrane cleaning approaches that include feed-back, and forward flow and direct osmosis cleaning. From the MSLD operational data, we will develop a comprehensive process model that will include theoretical deterministic elements, neural-based machine learning, empirical parameters derived from the modular multi-stage laboratory desalter (MSLD), as well as long-term historical RO plant data.

Subsequently, we will adapt and demonstrate the use of novel scaling and fouling sensors, developed at the WaTeR Center, with traditional sensors of flow, pressure, and water quality (i.e., hard sensors). We will then employ an advanced process optimization methodology that processes inputs from water quality data, the MSLD, the process model, the fouling/scaling sensors through a cognitive, neural network (i.e., soft sensors). The overall optimization methodology will rigorously account for operational constraints imposed by fouling and scaling, in addition to the normal range of operating variables during high recovery operations. Finally, we will develop and test a novel process control strategy that relies on real-time inputs from the hard and soft sensors to provide real time feedback-control of system performance. This approach will provide for both real-time control of necessary feed pretreatment and dynamic scale mitigation strategy that relies on allocation and redirection of feed streams.

Our goal is to demonstrate that significant reduction of the cost of brackish and ocean water desalination in California can be achieved (~20-30 percent) over the next three years by integration of adaptive process and control technologies to enable reliable, continuous operation of high efficiency multi-stage membrane desalination systems.

The proposed research will be conducted with participation and support from the University of California, industry, utility, and water agency partners. The proposed research project will benefit from resources available to the UCLA WaTeR Center and from ongoing collaborations with its industrial and government affiliates. Rapid dissemination of information regarding scientific and technological innovations will be of high priority in the proposed project. Information gained from the proposed project will be made publicly available through a project web site and disseminated via publication of scientific reports, journal articles, conference presentations, seminars and public workshops. In addition, it is expected that graduate and undergraduate students, trained as part of the proposed research, will join the professional workforce that designs, operates, and maintains California's existing and planned desalination infrastructure.

Grantee: **Bureau of Reclamation**
 Entity Type: **Federal Agency**
 Project Title: **Development of New Chlorine-Resistant Reverse Osmosis membranes**
 Project Type: **R&D - Brackish Water and Seawater**

Total Project Cost: **\$2,554,394**
 Requested Funds: **\$498,679**
 Awarded Grant: **\$498,679**

Assembly District: **76**
 Senate District: **39**
 Congressional District: **5**

County: **San Diego** City: **San Diego, CA / Yuma, AZ**
 Latitude: **32 43 N / 32 69 N** Longitude: **117.09 W / 114.62 W**

Project Summary:

For consideration for cost sharing by the California Department of Water Resources in addressing a critical deficiency in reverse osmosis technology, the Bureau of Reclamation (Reclamation) submits an applied research and development project: Development of New Chlorine-Resistant Reverse Osmosis Membranes.

Desalination of seawater and inland brackish waters offers new drought-proof water supplies. Reverse osmosis (RO) with polyamide (PA) membranes has proven an effective desalination technology to desalinate and purify contaminated sources.

With algae-laden seawater and other surface waters, RO pretreatment processes and RO desalination operate best with chlorine disinfection (bleach). Unfortunately, chlorine chemically attacks and degrades PA membranes. If chlorine is used in the RO pretreatment (for example, to reduce ultrafiltration (UF) fouling or for UF cleaning), it must be removed before the water enters the RO equipment. Without disinfection, biological regrowth fouls and plugs the RO membranes and greatly reduces RO membrane capacity and life.

The RO industry considers it critical to develop PA membranes that can operate with waters disinfected with chlorine or other oxidants. In 2001, industry experts identified the need for chlorine-resistant PA membranes as the number one priority of all desalination research and development needs (National Water Research Institute, "Desalination Research & Development Workshop Report," Kellogg West Conference Center, Cal Poly Pomona, January 19-21, 2001, page 8

<http://www.nwri-usa.org/asp/bookdetails.asp?id=4&main=m4&sub=s4&Action=prom&ProdID=60>).

Reclamation's 2003 Desalination and Water Purification Technology Roadmap (<http://www.usbr.gov/pmts/water/media/pdfs/report095.pdf>) identified developing "oxidant resistant" membranes as a needed membrane research technology area (see page 30, table 2).

With present and past funding by Reclamation and the Army Research Office, we have determined that the PA-membrane chemistry can be modified to make membranes resistant to chlorine and other oxidants. Because the underlying mechanism of chlorine attack on the PA desalination layer is polar, not radical, it is possible to modify the PA membrane chemistry such that chlorine can be tolerated. We have established the requirements for both the amine and acid chloride monomers to produce a chlorine-resistant PA membrane.

We propose to make chlorine-resistant PA membranes from a group of monomers we have identified and test the best membranes in single-pass, long-term tests at the Water Quality Improvement Center (WQIC) in Yuma, Arizona (http://www.usbr.gov/lc/yuma/facilities/wqic/yao_facilities_wqic.html).

Grantee: **Lawrence Livermore National Laboratory**
 Entity Type: **Federal Agency**
 Project Title: **Desalination Using Carbon Nanotube Membranes**
 Project Type: **R&D - Brackish Water and Seawater**

Total Project Cost: **\$749,345**
 Requested Funds: **\$249,345**
 Awarded Grant: **\$249,345**

Assembly District: **15**
 Senate District: **9**
 Congressional District: **10**

County: **Alameda** City: **Livermore**
 Latitude: **37.4055 N** Longitude: **121.460 W**

Project Summary:

Over the period of 1 year we propose to demonstrate anion and cation selectivity using sub-2nm membranes that have carbon nanotubes (CNTs) as pores. We will demonstrate feasibility of desalination using our membranes whose pore sizes are comparable to traditional RO membranes. We are uniquely positioned to do this because we are the only group in the world that can fabricate carbon nanotube membranes with diameters <2nm (Holt et al. "Fast Mass Transport Through Carbon Nanotubes", Science, in press). Our previous measurements of water flow rates through these membranes revealed up to 2 orders of magnitude higher permeabilities than those of conventional reverse osmosis membranes. Preliminary experiments in which membrane charges were not controlled indicated reduction in sodium ion concentration after passing through our membrane, giving us confidence in a successful outcome to this study.

In this feasibility study we will leverage the process for fabrication of the membranes developed in a previously internally funded project (LLNL Laboratory Directed Research and Development). We will then employ simple chemistry to change charge at the ends of the nanotubes and make the membranes selective to either positive or negative ions through a combination of size and charge selectivity. Our goal is to demonstrate ion exclusion while preserving high permeabilities and low energy use. Success of this feasibility study will warrant further developments in the fabrication of membranes that use anti-fouling materials such as paraflex, as well as the development of membrane processing for large scale applications.